First Copy

MODERN PLASTICS

MAY 1942

HOW TO LOCATE NEW YORK, N. Y., on the map of South America!

JOHN VASSOS, *Industrial Designer*

ACCUSTOMED AS WE ARE to constantly improved design . . . what could be more commonplace to the average American citizen than a fine, streamlined table-model radio?

Yet wire that radio for short wave reception . . . distribute it throughout South America . . . tune it to *our* good-neighbor broadcasts—and you're helping to write the future history of Pan-American commercial relations . . . bringing the broadcasting studios of New York as close to Rio as Copacabana beach!

But let John Vassos tell you about this "commonplace" table-radio . . .

"Collaborating with the RCA Manufacturing Co., Inc., I designed this radio set especially for use in Latin America. In experimenting with different materials for the housing, we finally selected a Durez plastic. It met every design requirement; proved particularly economical on a mass-production basis; possessed the durability to withstand the rigors of deep-water transportation and the extreme differences in climate between points of manufacture and distribution. Not only were sales outstandingly successful, but also we were able to establish a definite Latin American preference for a U.S. radio over competitively priced foreign sets."

To business and industry . . . planning for greater Pan-American trade after the Victory . . . this radio points up Durez plastics afresh as the materials of "tomorrow." Their versatility and efficiency are understood in any language. Would you like to keep abreast of plastics developments? A request on your letterhead will bring *Durez Plastics News* to your desk every month.

DUREZ...plastics that fit the job

DUREZ PLASTICS & CHEMICALS, INC. DUREZ 1125 WALCK ROAD, N. TONAWANDA, N. Y.

CALLS FOR *ACTION* CALL FOR *Catalin*

...and in the AIR, too!

Pilot seats of Cotton Fabric impregnated with a Catalin Laminating Varnish and molded into rigid shape have successfully met all requirements in tests at Wright Field. Developed by the Capac Manufacturing Co. of Capac, Michigan, these seats not only effect a saving in weight, but release vital aluminum formerly used.

Catalin is a reg. trade mark

"How Fast?" . . . "How Practical?" . . . "How Many?" . . . or "How Few?" . . . These are the important questions today! Among the many plastic materials, Catalin alone offers a quick and easily adaptable process allowing complete freedom of design regardless of quantity, size, shape, thickness or color . . . and without the necessity for time consuming, complicated, expensive molds and molding equipment.

For example, the shock-resistant, translucent dials illustrated above were cut from 3/16" stock Catalin sheets, beveled and silk-screened to specifications. The pointers were cut from stock 3/4" Catalin sheets and machined to shape. When quantity justifies it, the construction of an inexpensive dipping arbor reduces fabrication to a minimum. In any case, whether Catalin is fabricated from sheets, rods, tubes or cast to shape, the time factor is days instead of months.

Catalin's physical properties are highly desirable in many applications where vital aluminum and stainless steel were formerly used. It is a thermosetting cast phenolic resin, with unusually high compressive, flexural and tensile strengths. It resists oils, acids, grease or lubricants, is non-inflammable and practically non-water-absorbent.

For production jobs that call for action—*Call for Catalin.* Our chemical and engineering staffs will cooperate with you in every detail.

CATALIN CORPORATION • ONE PARK AVENUE, NEW YORK, N. Y.

Cast Phenolic Resins, Polystyrene Molding Compounds, Phenolic Liquid Resins

PROTECTION . . . for America

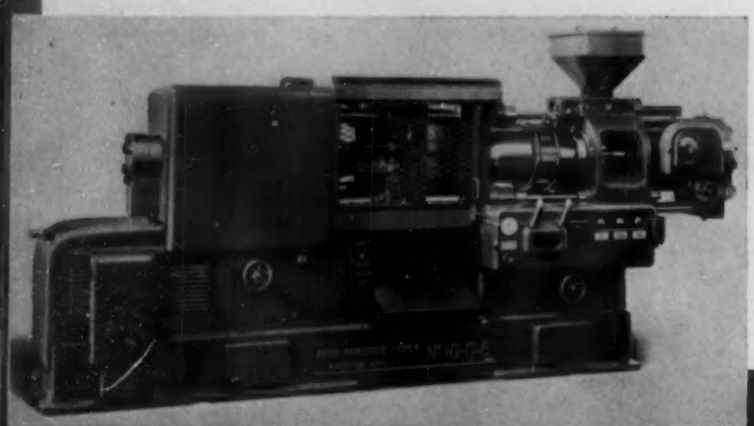
REED-PRENTICE MACHINES

PROVIDE PROTECTION FOR VITAL AIRCRAFT SPARK PLUGS

Here's a case where injection molded plastics play a little-known, yet important role in the defense program. These threaded Tenite shields protect both ends of an aviation spark plug (as shown lower right) during transit to the aircraft plants.

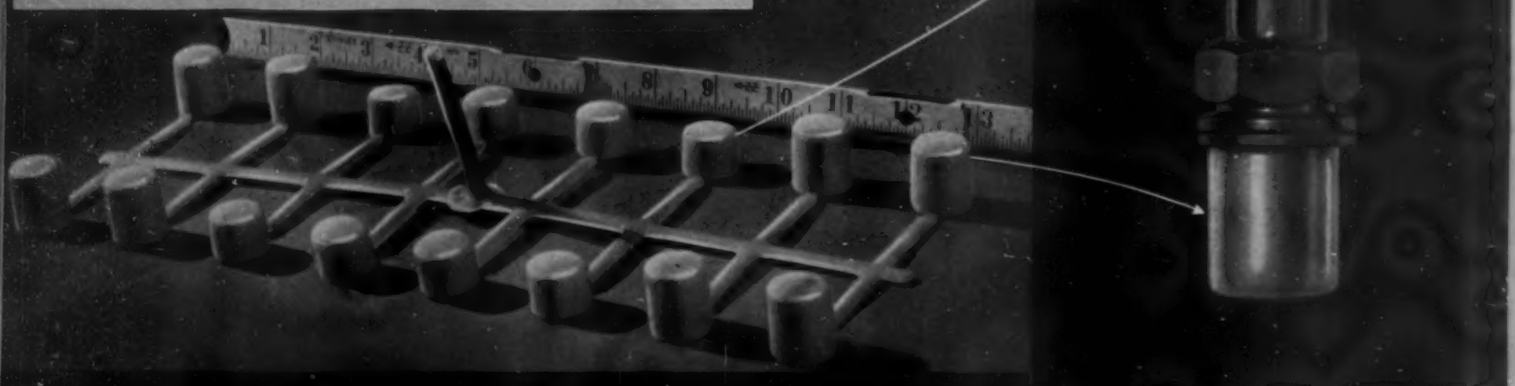
Of course, the primary purpose of these shields is to protect the accurate setting of the points until the plug is actually installed in the airplane motor. They're molded on a Reed-Prentice 6 ounce machine by Peerless Molded Plastics, Inc., Toledo, Ohio, for Champion Spark Plug Co.

Perhaps you have a possible application that is just as unusual, where injection molded plastics will serve an important purpose, at the same time releasing valuable metals for other defense needs. If you have, be sure to investigate Reed-Prentice equipment—it has what it takes to assure you real outstanding results.



(At left) Reed-Prentice No. 10D-8 oz. Injection Machine. Also available are 4 and 6 ounce sizes.

"Reed-Prentice features covered by Patents Pending"



REED - PRENTICE CORP

WORCESTER, MASS. U.S.A. NEW YORK OFFICE 75 WEST S

CLEVELAND OFFICE — PENTON BLDG. 1213 WEST 3RD. ST.

457 MACHINES IN SUCCESSFUL OPERATION

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modern plastics

MAY 1942

VOLUME 19 NUMBER 9

HARRIS & EWING

JUNE

One of the outstanding uses for thermoplastics in the war program is in military and civilian gas masks. The first complete story covering the part molded plastics are playing in chemical warfare, as shown in the mask pictured above, will appear in the June issue.

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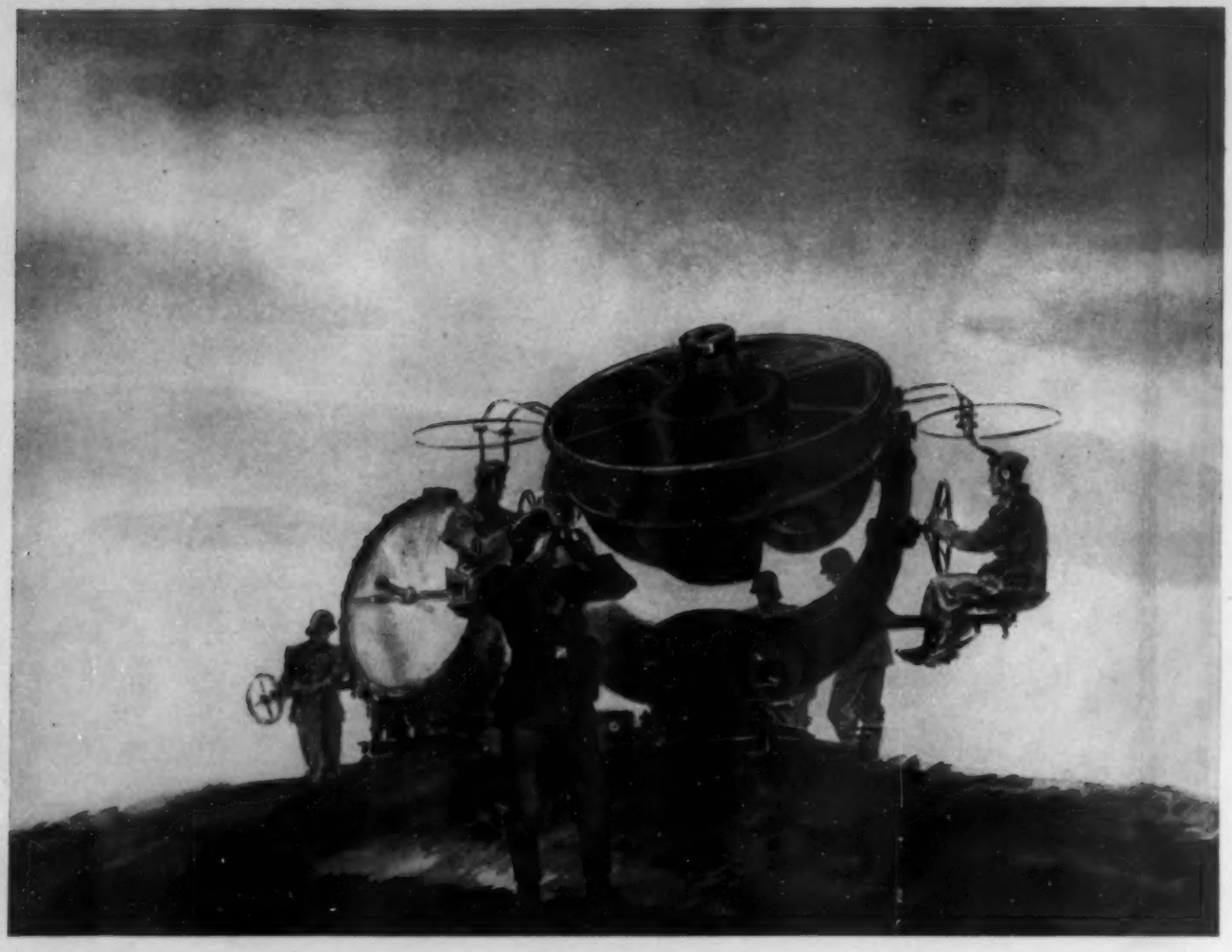


My, what big ears you have · · · Herr Hitler

YES, big ears to hear things not meant for them. And big eyes looking for things they should not see—*just yet.*

You, Adolph, would be very much interested in some of the things we're developing for you. American resourcefulness, ingenuity and the determination to win are now at work. And the great plastics industry is performing miracles in the battle against time and production obstacles.

Richardson Plasticians, for example, are doing things that "can't be done"—producing better products which save other critical materials for other essential jobs—helping numerous producers increase their output per machine-hour.

Soon, Herr Hitler, you'll know just what we've been doing and how fast we've been doing it.

War Products Producers Please Note:

If you have a problem which laminated or molded plastics might solve, write us about it. We'll do our best to give you the answer quickly.

The Richardson Company, Melrose Park, Ill.; Lockland, Ohio; New Brunswick, N. J.; Indianapolis, Ind. Sales Offices: 75 West St., New York City; G. M. Building, Detroit.

A few of the ways in which Insurok and the Richardson Plasticians' experience are now serving:

1. Increasing output per machine-hour
2. Shortening time from blueprint to production
3. Facilitating sub-contracting
4. Saving other critical materials for other important jobs
5. Providing greater latitude for designers
6. Doing things that "can't be done"
7. Aiding in improved machine and product performance

INSUROK

We made 43 technical advisory calls on plastics problems in a typical month... we'll be glad to make yours the 44th!

IF YOU could shadow a *Du Pont Technical* man on his rounds, you'd learn a lot on how to get more out of plastics!

In a month you'd run into plenty of plastic puzzlers. You'd find knotty problems like your own laid on the table before the Du Pont man. And you'd hear him probe deep into the matter. If the question is one that's hard to crack on the spot, you'd see him take it back to the plant for review and consultation by the *Du Pont Technical Committee.*

With Du Pont, research goes out beyond the laboratories that developed "Lucite," nylon, Cellophane and other materials. It extends to the technical representatives, who are kept informed of the newest developments of research. The Du Pont "know-how" is carried into the field. It's the job of the Du Pont man to help you make the most of materials and techniques.

So if you have a plastics problem—of replacement, design, molding or fabricating—feel welcome to discuss your plans with the Du Pont Technical man. He'll give you the best of our practical knowledge, research facilities, and experienced judgment. E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Arlington, N. J.

DU PONT

REG. U.S. PAT. OFF.

PLASTICS

"Lucite" methyl methacrylate resin
"Plastacele" cellulose acetate plastic
"Pyralin" cellulose nitrate plastic

What some of the 43 calls a month have involved:

• • •

1. Assist molder to improve impact resistance of molded lens.
2. Give information on molding a calibrated dial.
3. Discuss advantages of plastics as metal substitutes.
4. Cooperate in study of powder movement in injection cylinder.
5. Provide technique for ashing and polishing resin articles.
6. Aid in elimination of weld lines from molded piece.
7. Discuss flow pattern in intricate mold.
8. Demonstrate polishing walls of drilled holes.
9. Develop special cement for "Plastacele"
10. Assist in molding finger nail and hair brush backs.
11. Review design of 16 cavity die.
12. Eliminate bubbles from large molding.

HIT 'EM WHERE THEY AIN'T

Willie Keeler was a batting star not because he murdered the ball, but because he was one jump ahead of the other guys in directing his hits.

In plastics it works out that way, too. The company that brings out a new application ahead of its competitors is the one that captures the lion's share of the market.

MORAL

Today, when the emphasis is on molding, molding and still more.... molding....the smart boys are putting their ideas through the wide gap in development work. They're having molds—production or experimental—built, now that the toolmakers' bottleneck has been uncorked. They're getting ready for the time when the surge is all *back* to the toolrooms. *Then* their already-made molds will take precedence in pressrooms that will be eager for work. They'll be getting the cream of production facilities for their moldings while their competitors are still waiting for blueprints.

The idea is—start work, *now*, on your new developments. Be ready for the release of materials that is coming as sure as your income tax. We'll be glad to talk it over with you.

"A Ready Reference for Plastics" written for the layman, is now in a new edition. If you are a user, or a potential user of molded plastics, write us on your letterhead for a copy of this plain non-technical explanation of their uses and characteristics.

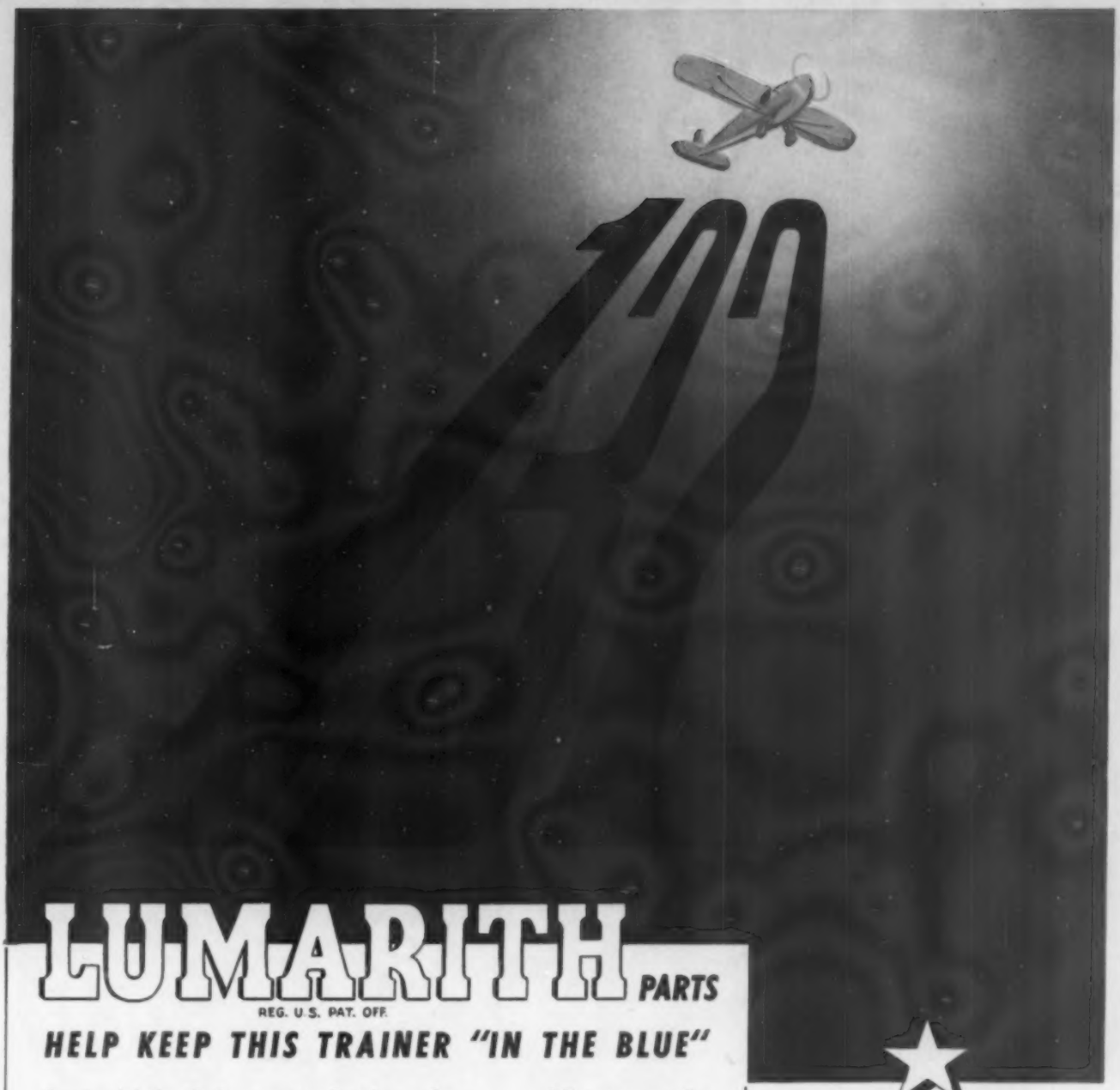
BMCB

BOONTON MOLDING COMPANY

MOLDERS OF PLASTICS · PHENOLICS · UREAS · THERMO PLASTICS

BOONTON · NEW JERSEY · Tel. Boonton 8-0991

N. Y. Office—Chanin Bldg., 122 East 42nd Street, Murray Hill 6-8540



LUMARITH PARTS

REG. U.S. PAT. OFF.

HELP KEEP THIS TRAINER "IN THE BLUE"

Lumarith is aloft constantly these days . . . adding strength, subtracting weight and reducing cost in scores of 'plane-parts from the spinner to the tip of the tail.

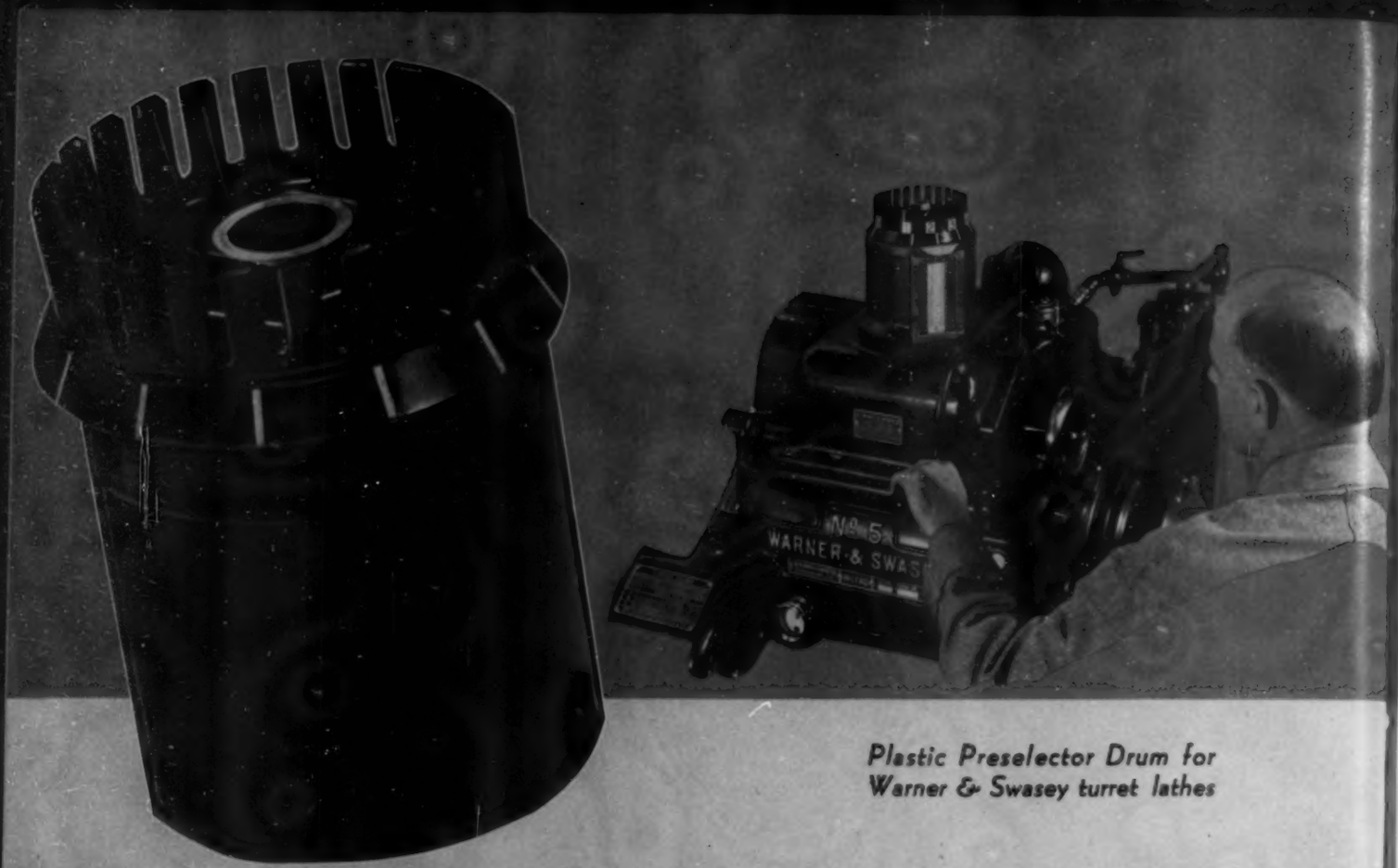
This is one of the more exciting ways in which Celanese Celluloid products and experience are serving the war effort. Other applications, less publicized but equally vital, extend to practically every war industry, and the list grows larger day by day.

TO MANUFACTURERS WORKING ON WAR ORDERS

As the founder of the plastics industry, we have experience records and other data which we are eager to share with other companies in the "Victory business." On contracts where plastics are required, or where plastics can speed production, the knowledge of our engineers is at your disposal. Address *War Materials Division* for quick identification and attention.

Celanese Celluloid Corporation

Celanese Celluloid Corporation, 180 Madison Ave., New York City, a Division of Celanese Corporation of America. Sole Producer of Celluloid* (cellulose nitrate plastics and dopes) . . Lumarith* (cellulose acetate plastics and dopes) . . Lumarith Protectoid* (transparent insulating, laminating and packaging material) . . H-Scale* (synthetic pearl essence) . . Lindol* (plasticizer and lubricant additive) . . Samson* and Safety Samson* Film Bases . . and Vimlite* (shatterproof window material). . . *Trademarks Reg. U.S. Pat. Off.



Plastic Preselector Drum for Warner & Swasey turret lathes

THERE'S NO PRIORITY ON *Ingenuity*

RMP

SALES OFFICES

MINNEAPOLIS
(ATLANTIC 3285)

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(FRANKLIN 2780)

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CHICAGO
(MONROE 2426)

NEW YORK
(LEXINGTON 2-3030)

BUFFALO
(GRANT 8567)

CINCINNATI
(CHERRY 2422)

To save 1400 pounds of aluminum per month, The Warner & Swasey Co. turned to plastics in the manufacture of their Preselector Dial Drums. Not only do they conserve aluminum needed so urgently for Defense, but they save 80% in manufacturing costs for this part. To make this saving, they came to Reynolds. Let Reynolds show you how you can also save.

REYNOLDS MOLDED PLASTICS

CAMBRIDGE, OHIO, U. S. A.

DIVISION: REYNOLDS SPRING COMPANY • JACKSON, MICHIGAN, U. S. A.

"LIKE CUTTING THROUGH BUTTER ... PHILLIPS SCREWS TAKE THE HARD WORK OUT OF FASTENING"
BUTTER
"AND DON'T FORGET! PHILLIPS SCREWS COST LESS TO USE"

Easier Screwdriving • Freedom from Accidents • Tighter Seating = 50% Less Assembly Cost with Phillips Screws

You'd know the difference if you were doing the job. In fact, executives who have their own home workshops are usually the quickest to see the advantages of the Phillips principle and adopt it for their firm's assembly work.

It really *is* easy to drive Phillips Recessed Head Screws. You get a better "grab" on the screw because the driver point and Phillips recess make a snug fit. There's no danger of the driver slipping, so you don't have to spend a good part of your effort holding it in — you just keep *turning*. And there are more jobs on which you can use power drivers.

Translate this *ease of driving* into time and then time into dollars. An operator can, on the average, cut fastening time *in half*. Figure it out for yourself — then add the savings you get from using fewer screws (better holding power often reduces number or size of screws needed), spoiling fewer screws (no split screw heads) and eliminating the cost of resurfacing screw-driver scars.

The Phillips Screw is certainly the *modern* fastening method — which means "better" and "more economical." Any of the firms below can supply you.

PHILLIPS RECESSED HEAD SCREWS GIVE YOU 2 for 1 (SPEED AT LOWER COST)

WOOD SCREWS • MACHINE SCREWS • SHEET METAL SCREWS • STOVE BOLTS • SPECIAL THREAD-CUTTING SCREWS • SCREWS WITH LOCK WASHERS

American Screw Co., Providence, R. I.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
The Charles Parker Co., Meriden, Conn.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., Chicago, Ill.
Russell, Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Scovill Manufacturing Co., Waterbury, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
Whitney Screw Corp., Nashua, N. H.

• Another advertisement telling how different American industries are speeding up wartime production •

We've got to keep giving him 13 EXTRA *to win the war*

Taylor Instruments are helping America's planes fly farther faster...

▶ We'll win this war in the air. We'll win it because our planes are powered by the world's best gasoline.

Our planes use high-powered, 100-octane gasoline. Our enemies depend on gasoline which averages 87-octane. This 13-point lead gives an American pilot ⅓ more power from his fuel than his opponent gets. Our boys can climb out of anti-aircraft fire 40% faster... fly higher than enemy planes of the same weight... get off the ground one-fifth faster. Our 100-octane gas reduces the fuel load so our bombers can carry 20% to 30% more bomb load, or fly farther with heavier armament.

We've got to "fill 'er up" for ourselves and our allies with three times as much 100-octane aviation gasoline as we're producing now—increase production to 5 million gallons a day! We can. We're going to. We're doing it. Taylor Instruments are helping the speed-up.

From pilot plants through commercial plants, Taylor Instruments and Taylor engineers have been a vital help in producing high-octane gasoline. Now *every* gasoline refiner considers instruments essential. Taylor Instruments insure precision processing—automatically accurate and constant control of complicated chemical and physical reactions—complete, dependable uniformity—lower operating costs—more, *better* production.

With Taylor Instruments indicating, recording and controlling temperatures, pressures, liquid levels, rates of flow in all the perplexing, exacting refining operations, America's great oil industry *is* producing the high-grade gasoline and lubricating oil we need—and *can* produce more... *more*... MORE!

Uncle Sam and our allies are relying on Taylor Instruments to help produce:

100-OCTANE AVIATION GASOLINE
...in plants of the biggest producers of this type of fuel.

HIGH-GRADE LUBRICATING OIL
...in plants producing the quantities needed by tanks, cars, planes.

BETTER ASPHALT
...in plants furnishing this "quick take-off" surfacing for airfield runways and highways.

Without help from the oil industry, America couldn't win the war. Without the aid of automatic control instruments of the types made by Taylor, the oil industry couldn't hope to do its staggering job. Without Taylor Instruments, many another American industry could never have speeded up victory production. Are Taylor Instruments helping you do *your* war work? Have you called in Taylor engineers, to suggest ways of *getting more* out of your present equipment? Are you really tuned up to turn it out? Taylor Instruments will help you *now*—America needs you *now*. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada. Makers of the famous "Not 1 but 5" Fulscope Controllers.

Taylor
Indicating Recording Controlling
TEMPERATURE, PRESSURE, FLOW and LEVEL INSTRUMENTS

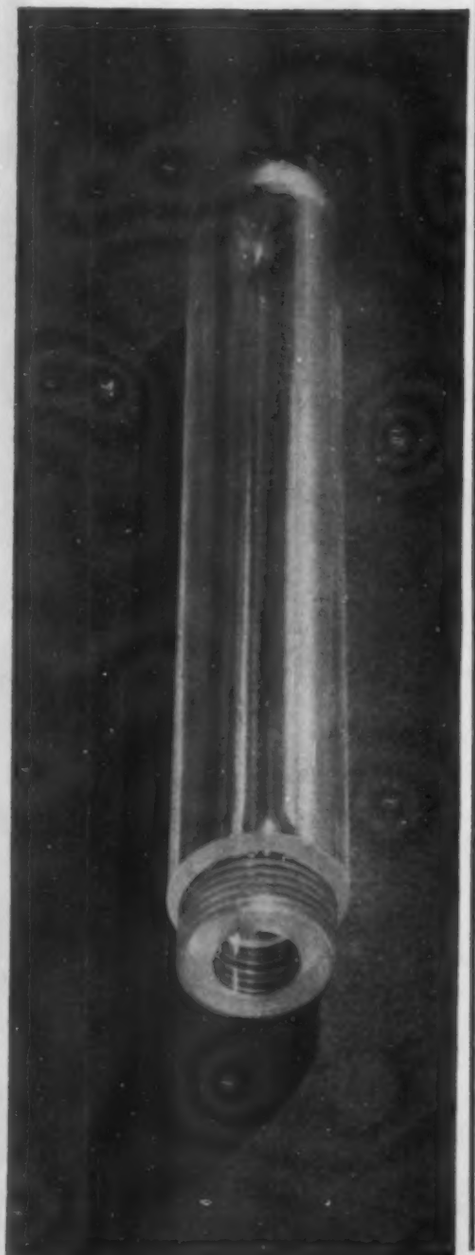
★ ★ ★ HELP BEAT 'EM BY BUYING U. S. DEFENSE BONDS ★ ★ ★

Crystalite *and* Plexiglas

★ ★ ★

For Strong . . . Permanent . . . Light Weight . . . Transparent Industrial Parts

Molded from CRYSTALITE



WHETHER you fabricate from PLEXIGLAS sheet or mold from CRYSTALITE powder, you will find acrylic plastics ideal for industrial parts.

Unaffected by salt water, battery acids, oils, grease and most other chemicals, PLEXIGLAS and CRYSTALITE do not warp nor discolor even on exposure to severe weather conditions. They can be broken only by a hard direct blow. They are excellent electrical insulators.

Clearer than glass, and less than half as heavy, they have proved their rugged permanence on the Navy's new small boats, on Army tanks and trucks, on every type of fighting plane built in America.

Experienced Rohm & Haas representatives will be glad to show you how CRYSTALITE and PLEXIGLAS can be used for instrument covers, gauge glasses, safety shields, inspection windows and in many other places on combat or production equipment.

Left picture—Oil gauge glass injection molded of CRYSTALITE *by the Detroit Macoid Corporation.* CRYSTALITE *compression and injection powders are ideal for mass production of transparent plastic products.*

Right picture — Fuel gauge machined from PLEXIGLAS *rod by the Stricker-Brunhuber Corporation. Easily formed to any shape or machined to close tolerances,* PLEXIGLAS *combines clarity with strength.*

THE CRYSTAL-CLEAR ACRYLIC PLASTICS

PLEXIGLAS

SHEETS AND RODS

★

CRYSTALITE

MOLDING POWDER

PLEXIGLAS and CRYSTALITE are the trade-marks, Reg. U. S. Pat. Off., for the acrylic resin thermoplasties manufactured by the Rohm & Haas Company.

Machined from PLEXIGLAS

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA, PA.

Manufacturers of Leather and Textile Specialties and Finishes . . Enzymes . . Crystal-Clear Acrylic Plastics . . Synthetic Insecticides . . Fungicides . . and other Industrial Chemicals

◀ This high-tension connecting plug and socket, designed to meet government specifications is a vital unit in H. G. Fischer & Company's Shockproof X-Ray Apparatus. The parts, molded of high-dielectric phenolic material, must withstand a potential of 50,000 volts; the socket must also withstand continuous immersion in oil without leakage. Precision in molding is essential to insure uniform clearance when parts are joined.

EXACTING GOVERNMENT SPECIFICATIONS ON PLASTIC MOLDED PARTS

call first of all for a molder to whom exactness is not the exception but the general rule. Since Chicago Molded Products Corporation was founded, we have recognized only one standard of quality—the finest precision workmanship of which we are capable. Every operation in our plant, from the development of the design to the final finishing operation, is geared to this standard alone. That is why, year after year, leading manufacturers like H. G. Fischer and Co. have brought their exacting jobs in plastics to Chicago Molded. And why you, too, will find this a good place to come for your plastic molded parts, especially when there are exacting government specifications to be met.

- **COMPRESSION**
- **INJECTION**
- **TRANSFER**
- **and EXTRUSION MOLDING**
- **of SYNTHETIC PLASTIC**
- **MATERIALS**

FOR INSTANT ACTION on your war production job in plastics, phone us in Chicago, CAPitol 1020. A member of our engineering staff, fully qualified to help you with any government work involving plastics will be sent to you immediately, anywhere in the United States.

CHICAGO MOLDED PRODUCTS CORP.

1046 NORTH KOLMAR AVENUE CHICAGO, ILLINOIS

A Beautiful **CATALIN** *Product*

in the manufacture of
the Hair Brush Handle for
Parfumerie De Raymond, New York

LEA COMPOUND *removes the moulding fin*

LEAROK *provides the final high lustre*

THE Krest Manufacturing Co., Inc., South Norwalk, Conn., came to Lea technicians in search of recommendations and materials for finishing its Catalin products. The Lea Method evolved, using two of the many grades of Lea Compound and Learok, produced the desired finish more economically and efficiently than by any other means.

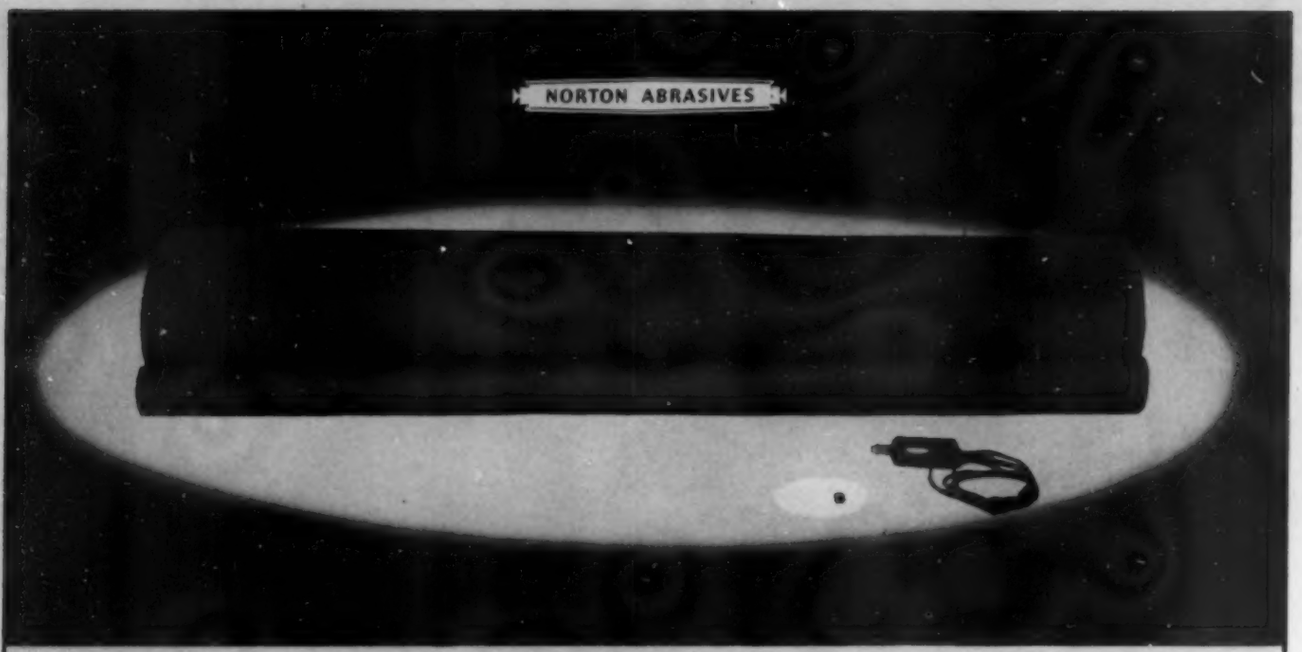
The basic difference between Lea Compound and Learok lies in the fact that the former has no grease or lubricant at all while the latter has no *free or surplus* grease. With more than a hundred different grades of these two compounds available, and with years of finishing experience to call upon, it is not difficult to visualize the importance of Lea's Finishing Service to the plastic industry.

In writing for further information, please give full particulars of product, plastic, and objective. Send samples, if possible.

THE LEA MANUFACTURING CO.

WATERBURY, CONN.

Specialists in the Production of Clean-Working Buffing and Polishing Compounds



"GOING TO EXTREMES". . . 20,088 to 1 IN SANDPAPER

That big belt 62 x 243 inches has 20,088 times the surface of that tiny ½ x ½ inch Spiraband, scarcely visible in the extra spotlight in the foreground, yet each is the only correct specification for its particular job.

Within these extremes are thousands of other shapes differing in mineral, grit size and backing, all "every day stuff" to us.

Ask one of our men to sit down with you over any puzzling finish ing problem. He'll put at your service all his practical experience of methods that save both time and money.

And what he recommends you can bank on, for it's from a line that has pioneered better and still better coated abrasives for seventy years.

Dependable Coated Abrasives Since 1872

BEHR-MANNING
(DIVISION OF NORTON COMPANY)
TROY, N. Y.

LAST MAN UP IS A GONER!

How Resinox, the lightweight, heavy-duty plastic, is helping U. S. pilots win the life-and-death race for altitude

The problem: To feed combat pilots a steady, absolutely reliable flow of oxygen at the dizzy altitudes to which they must climb today for victory . . . and to do it with the least possible interference to their fighting efficiency.

The solution: This light, comfortable sub-stratosphere oxygen mask, manufactured by the Ohio Chemical and Manufacturing Company for the U. S. Army Air Corps using Resinox parts molded by Minneapolis Plastic Co.

In the vital parts you'll find no metal to freeze to flesh at high altitudes, no moving parts to chill and stick . . . only Rubber and Resinox!

The rubber is specially compounded to resist hardening at paralyzing sub-stratosphere temperatures. Resinox, of course, is Monsanto's lightweight, heavy-duty phenolic plastic.

In the words of the manufacturer, Resinox was "ideally suited" for the saddle, connector and plug of this mask, "first, because it is light in weight; second, it is durable; third, it is not appreciably affected by extreme low temperatures encountered at high altitudes."

For full details and technical assistance in adapting Resinox to vital war uses, inquire: MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield, Mass.

CONNECTOR SADDLE PLUG

PLAN TODAY FOR PLENTIFUL TOMORROW WITH PLASTICS

MONSANTO PLASTICS

SERVING INDUSTRY . . . WHICH SERVES MANKIND

THE FAMILY OF SIX MONSANTO PLASTICS

(Trade names designate Monsanto's exclusive formulations of these basic plastic materials)

LUSTRON (polystyrene) • **OPALON** (cast phenolic resin)
FIBESTOS (cellulose acetate) • **NITRON** (cellulose nitrate)
SAFLEX (vinyl acetal) • **RESINOX** (phenolic compounds)

Sheets • Rods • Tubes • Molding Compounds • Castings
Vuepak Rigid Transparent Packaging Materials

Production for Victory

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PLASTICS are serving in nearly every sector on the production front—replacing metals in many important jobs. Because of their light weight, superior structural strength, easy molding qualities, high electrical resistance and their ability to withstand moisture, oils and most acids, REILLY INDUR PLASTICS are inherently qualified for the exacting requirements of war service, and are being used in the manufacture of scores of instruments, devices and parts which are directly or indirectly essential to the production of fighting planes, ships, tanks and other war equipment. INDUR PLASTICS are available, therefore, through priority ratings and serve only for production for victory.

REILLY TAR & CHEMICAL CORPORATION

Executive Offices: Merchants Bank Building, Indianapolis, Indiana

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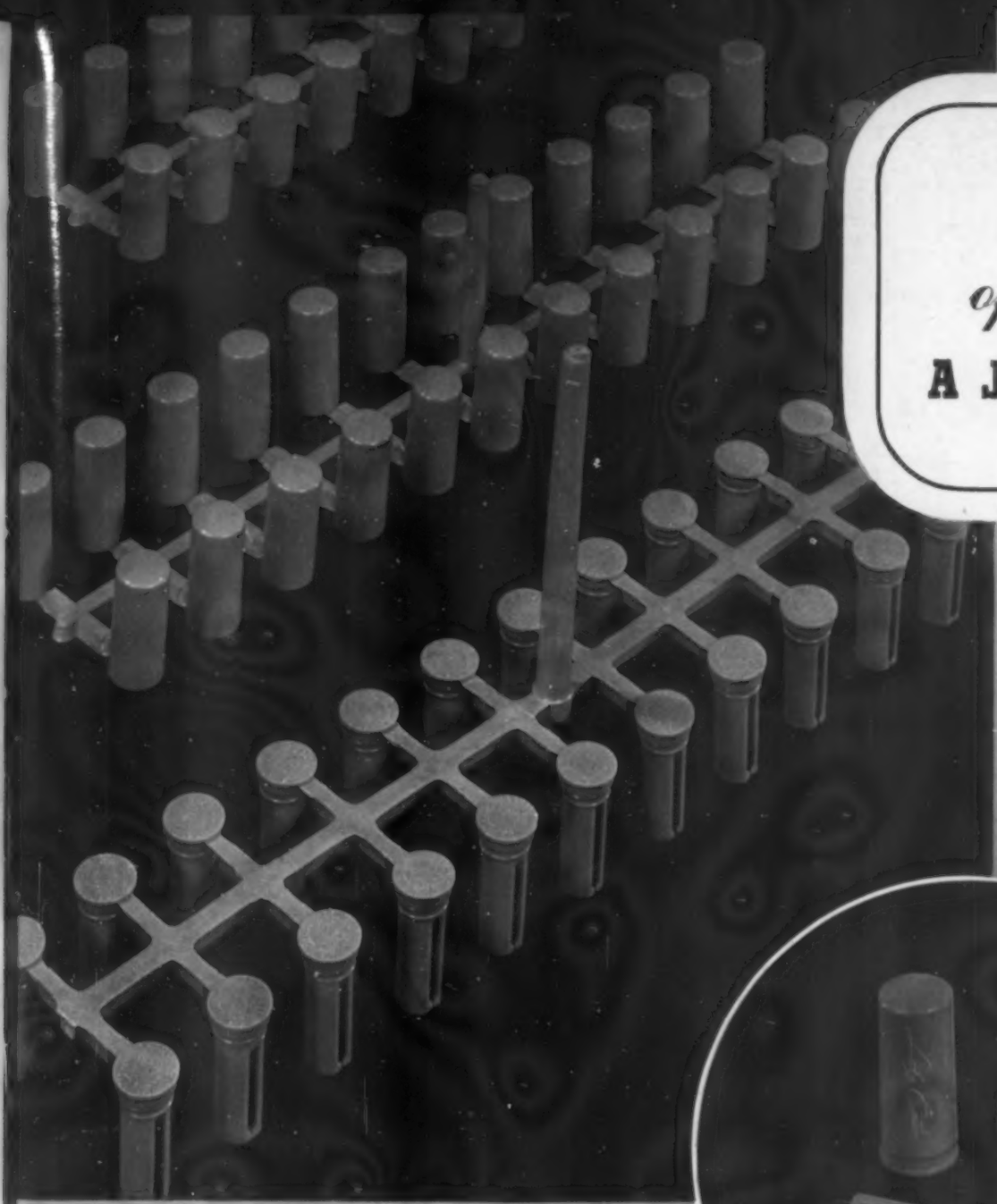

A Thing of Beauty is

A JOY FOREVER

—Keats

BEAUTY is the birthright of lovely womanhood and cosmetics are its handmaidens. Beauty, too, is the secret of successful cosmetic packaging and sales.

The charm that provides exciting eye appeal to lipstick containers is best captured with molded plastics that are correctly designed and engineered. The modern method of multiple unit injection molding permits economical and practical production with comparable efficiency for long or short runs.

Consult our engineers without obligation. Be sure to ask about ~~MILLS PLASTIC~~...it may be the answer to your wartime production problems.

Your signature on your letterhead brings you a copy of this catalog containing data and illustrations of molded thermoplastics and ~~MILLS PLASTIC~~

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when the Minute Man returns to his Plow ...it will have *Plastic* handles!

THE challenge has been hurled . . . and met!

From here on in, there can be but *one* objective—VICTORY!

Along with the students who have foregone their diplomas . . . along with the workingmen who have rolled up their sleeves . . . and along with the manufacturers who have converted their plants into full-time war production, the Plastics Industry has enlisted its tremendous facilities for the duration.

After the job is finished and the smoke of conflict rolls away, the warriors of the fighting front and the producing front will return to find quite a different world. Old, familiar things will have been made more beautiful, more useful, more durable and far, far more desirable because of PLASTICS.

And the many new things that they will discover—those miracles of modern science and mass production, will have also been brought about through PLASTICS—the very PLASTICS that are now helping to win the VICTORY.

For the Plastic Age has come upon us. Already firmly entrenched in every important industry . . . already welcomed and adopted in countless applications for the advancement of our industrial and private lives, the Plastics Industry will take the current emergency in its giant stride and pick up, not where it left off, but many, many milestones ahead on the path of Progress.

Designs now on the drafting boards, innovations still in the laboratories, will burst into a myriad of blooms under the very first warm rays of Peace. Seeds planted today in this most fertile of fields, will bring harvest after harvest in the productive years that lie ahead.

For the advertiser with raw materials or equipment or supplies or services to sell to those who produce and market plastic products today, as well as for the vast virgin multitude who are thinking about plastics today and planning to do something about it tomorrow, there is one all-embracing medium for effectively reaching the industry—That medium, the ONLY publication in the field, is MODERN PLASTICS!

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NATIONAL VULCANIZED FIBRE COMPANY

WILMINGTON DELAWARE

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★★★ *Broadening American Enterprise through Dependable Plastics* ★★★

NOT JUST STICKING TO OUR KNITTING

A Yarn About Kilgore Service!

IT'S a temptation to sit back and coast on your reputation and ability when you're known as an outstanding molder of plastics.

Not so with us at Kilgore.

We have a few ideas of our own as to what can and should be made of plastic.

Witness this Knitting Set successfully merchandised by Swift & Company in a nation-wide advertising campaign on Sunbrite Cleanser.

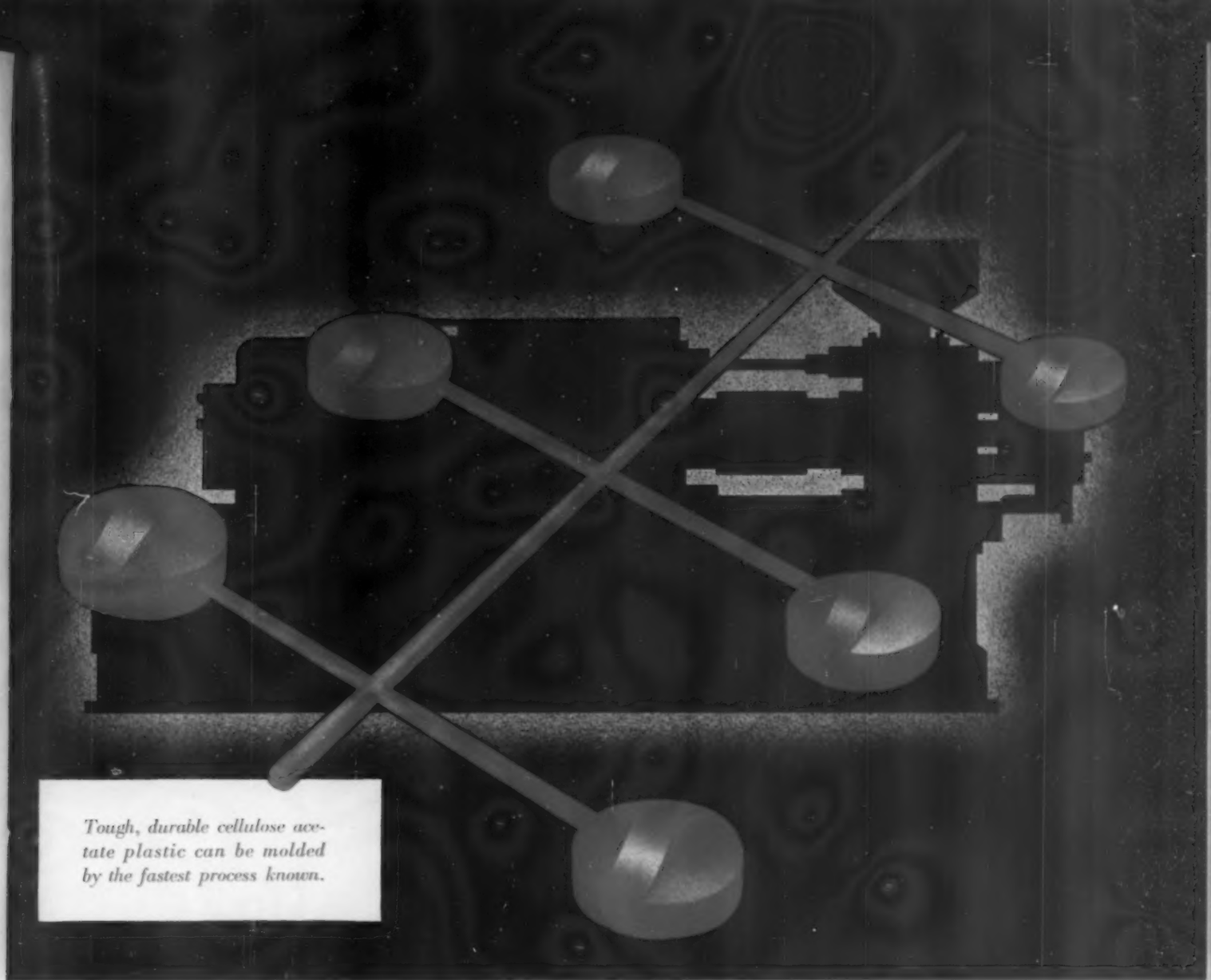
Conceived at an ideal time, when millions of women were turning to knitting as a result of the war, this promotion was a smash hit.

Our ideas are always at your service, whether in restyling present products, or developing new plastic applications.

Your inquiry will be given immediate attention.

KILGORE

Plastic Division of the Kilgore Mfg. Co., Westerville, Ohio



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War production requires so much plastic material that cellulose acetate plastic should be put to wider use for war products.

VALUABLE WAR MATERIAL—It is already used on scores of war jobs, such as parts of gas masks, and the tough streamlined housings protecting the loop antenna that picks up the beam for aircraft. But there are many more applications where the toughness, resiliency, light-weight, high dielectric strength, resistance to destructive agents, and ease and speed of fabrication can be used to advantage. Cellulose acetate plastic stands alone in combining so many good physical, chemical, and mechanical properties.

BRING BUYERS UP-TO-DATE—This extraordinary combination of advantages is enhanced by recent improvements in injection molding and in cellulose acetate molding powders. Plants, machines, skilled operators, and management are ready to jump into rapid production to help serve the war effort.

30,000,000 POUNDS A YEAR—Hercules does not make plastics, but through years of research we have helped to give cellulose acetate its unique combination of advantages—and improvement continues. The base material can be varied to make plastics with special characteristics to fit special requirements. Thirty million pounds a year, and over a thousand molding presses await a call for more products that will help to win the war.

Write Department MP-5 for literature.

DDD-47

HERCULES POWDER COMPANY · WILMINGTON, DELAWARE
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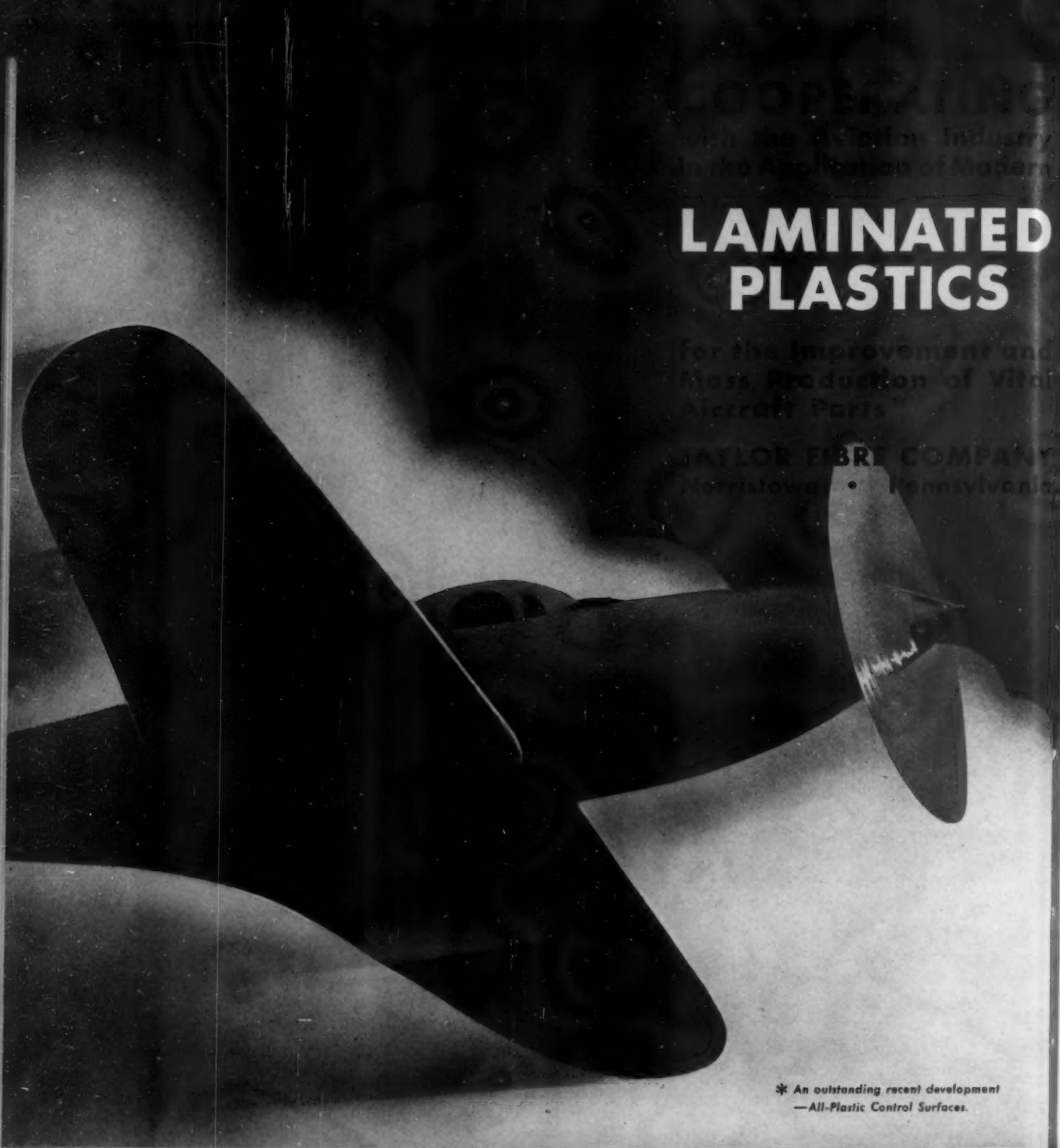

* An outstanding recent development
—All-Plastic Control Surfaces.

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LAMINATED PLASTICS • Vulcanized Fibre • Phenol Fibre •

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There's more to production than just a priority...

YOUR priority number, no matter how high, can guarantee you just one thing—and that is preference. In a molded plastic job, it won't guarantee you production to closest tolerances, nor finishing of the kind that cuts assembly hours to minutes.

That's why in these days of substitutes, new materials and unpredictable production schedules, it's more important than ever that you have all possible experience to help you solve your plastic molding problems.

Our sixty-six years of molding experience makes a lot of difference, our customers say. One described it as the "engineering skill to do the impossible." That's pretty strong, but perhaps our success with the tough jobs is due to the fact that as pioneers, we have had to figure ways of doing things for ourselves. And that habit has stayed with us.

If your defense job needs special skill, we suggest that it may aid our national program to get in touch with our engineering department.

MOLDED PLASTICS DIVISION OF

AUBURN BUTTON WORKS

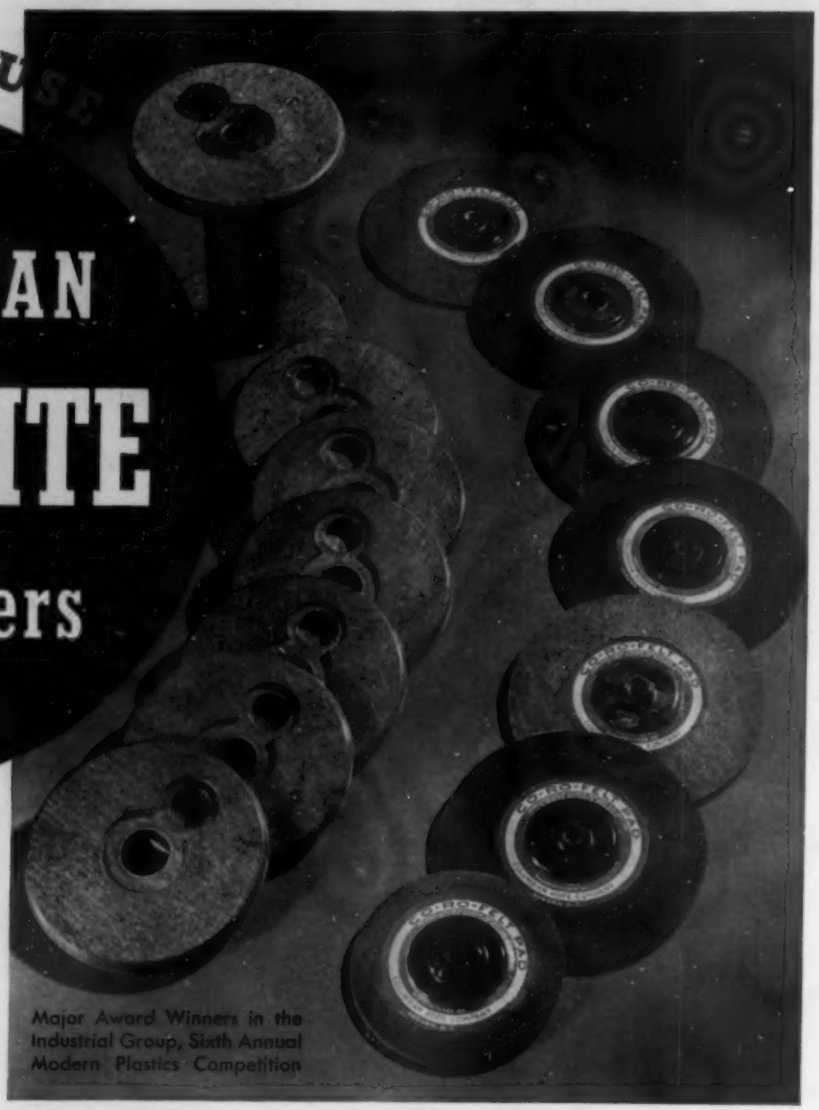
★ **AUBURN, NEW YORK** ★

Molders of all types of Thermo-Setting and Thermo-Plastic materials by compression, injection and extrusion methods

Now—The Economy and High Impact Strength of Laminates, plus MOLDABILITY

WHEN YOU U

COLUMBIAN CO-RO-LITE Sisal Fillers



Major Award Winners in the Industrial Group, Sixth Annual Modern Plastics Competition

NOW—get thermosetting plastics of HIGH IMPACT STRENGTH . . . in a wider range of molding shapes . . . a wider range of specific gravities . . . and a wider range of densities. By using Columbian CO-RO-LITE you can obtain weights and densities equivalent to wood . . . and you can actually blend rigidity with elasticity.

The Co-Ro-Lite process combines tough sisal cordage fibers into a fluffy batting and then consolidates the material by a needling operation which drives tufts of fiber through the mass. This Co-Ro-Lite filler has a volumetric composition of one part fiber to six parts void space, providing extreme lightness with a firmness sufficient to withstand the handling in applying the resins. Flash molds may be used. Penetration of resinous solutions is rapid, and receptivity to powdered substances, is high.

Sheets and molded shapes are produced, suitable for cams, gears, bobbin heads, bearings, tension and compression members, abrasive disk hubs and backs, as well as other industrial applications.

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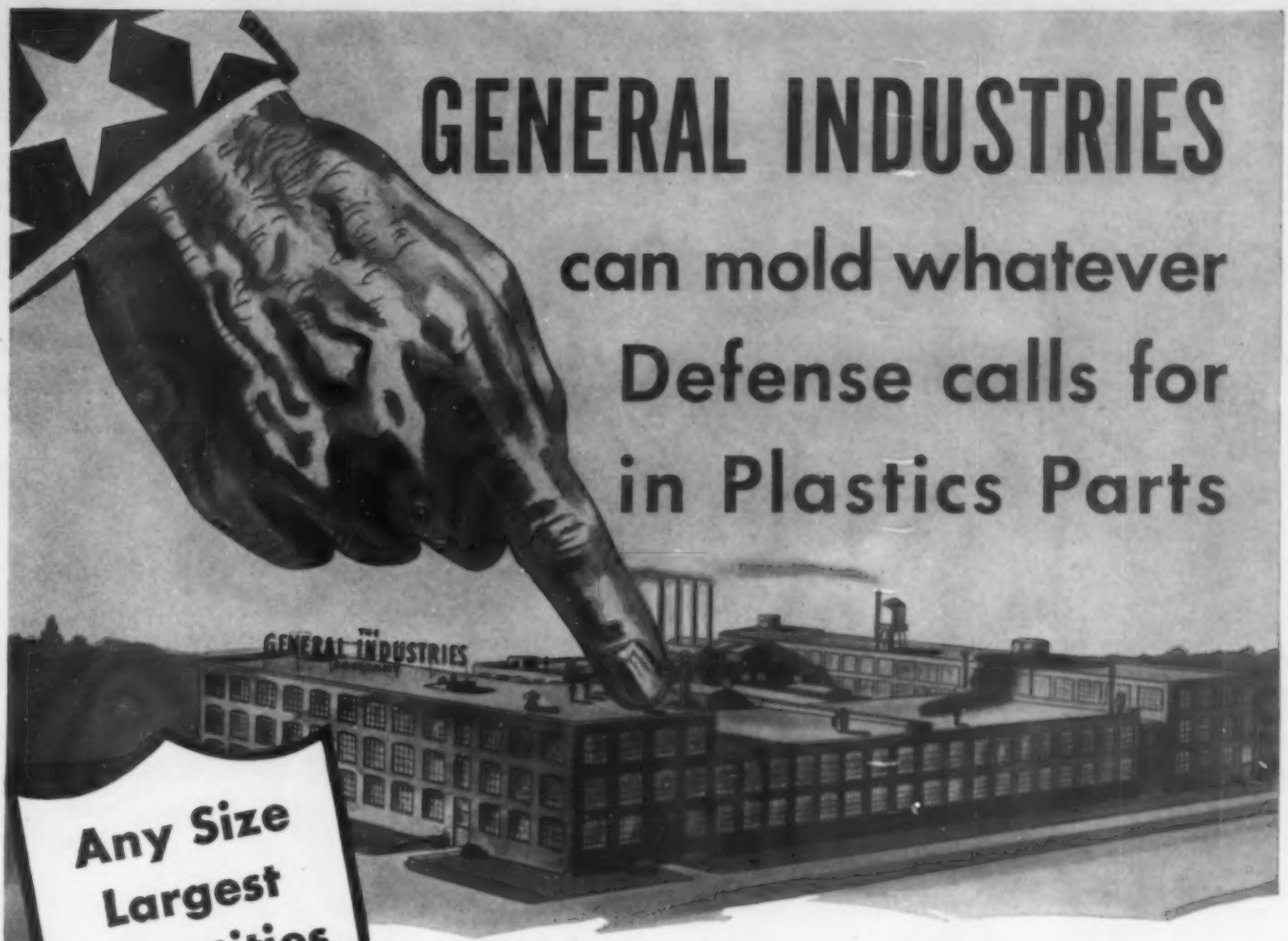

Any Size Largest Quantities ON TIME

Our facilities for producing molded plastics parts are not excelled anywhere. We are in position to undertake the largest assignments, handle them with ease, and deliver on time. You can rely on our engineers and workmen, long trained in all branches of molded plastics production, to take hold of your job and hit the mark right from the outset. No matter what your specifications call for in size, shape, material, quality or finish, you can confidently look to General Industries to meet your requirements in every particular.

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The GENERAL INDUSTRIES Co.

MOLDED PLASTICS DIVISION • • • • ELYRIA, OHIO

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You can learn about plastics in your spare time NOW—right at home. 44 Basic Lesson Assignments, written by the staff at PLASTICS INSTITUTE, bring you clear crisp definitions of the different types of plastics materials. Many actual samples of these plastics are included with the lessons for you to see—and test—right at home.

The machinery and methods of the plastics industry are clearly pictured and carefully described in these Basic Lesson Assignments—and brief examinations enable us to tell you each week just how you are progressing with your education in plastics.

This Plastics Course makes smart easy reading for spare evenings at home. Profitable reading, too, because it will give you the technical details of a fast-growing industry which needs better trained men. Will need more after the war!

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Not a Substitute

What General would consider the Modern Motorized Artillery as a temporary substitute for the slow . . . old time . . . horse-drawn cannon?

Changing times . . . changing conditions . . . demand new and better tools and materials.

"All-out" wartime production has made metals hard to get. Many manufacturers today are thinking in terms of replacing habitually used corrosive—weighty—costly materials . . . with NON-metallics.

Many of these change-overs will so improve products . . . and will be found to be so superior to the materials formerly used . . . that designers will never go back to the "horse-drawn cannon days."

Furthermore, a golden opportunity now exists for designers and engineers in C-D NON-metallic products. You who have been wanting to design new modern materials into your products can *now* do so with full approval of management.

C-D offers all such engineers an unique service. C-D makes *not* just one or two types of NON-metallics but FIVE distinctly different NON-metallic materials. C-D is, therefore, able to make and recommend the best NON-metallic material for a specific problem. Write today for Booklet GF-6 . . . "What Material?"

Continental-Diamond FIBRE COMPANY

Established 1895 . . Manufacturers of Laminated Plastics since 1911 — NEWARK • DELAWARE

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Have you been wondering where you can buy America's fastest machining, longest wearing tool and die steel—Graphitic Steel?

There's a Graphitic Steel distributor near you. Ask him for more information or place an order today. He carries a stock of all five grades of Graphitic Steel—Graph-Al, Graph-Sil, Graph-Tung, Graph-Mo, and Graph-M.N.S.

The phenomenal popularity of Graphitic Steel is based solely on its superior machining qualities and endurance. It will be popular in tough post-war competition for these same reasons.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO
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Manufacturers of Timken Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; Timken Alloy Steels and Carbon and Alloy Seamless Tubing; and Timken Rock Bits.

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GRAPHITIC STEELS

What Can A Plastics Manufacturer Do

to help win this war?

THE one thing we can do, and are doing, to help win this war is to produce new and constantly better materials. This means keeping up to our quality production of present plastics and the development and production of new formulas to do new jobs.

WHERE CAN THESE MATERIALS BE USED?

Some are being used in the making of weapons for the U. S. Army and Navy, in ammunition, etc. Others are being used in industry to release the less-available materials for war industries.

We'll be glad to work with any molder or manufacturer who wants to know what our plastics can do. We'll supply him with whatever materials priorities allow.

OUR SPECIALTY IS SERVICE

We take a personal interest in each customer . . . work right with each . . . give each whatever help we can.

The Independent Producer of Superior Plastics

Makalot CORPORATION

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MOLDING COMPOUNDS • FABRIC AND PAPER IMPREGNATING RESINS • TUBES, RODS AND SHEETS • PHENOLIC LACQUERS • VARNISHES • SOLVENTS

Central States Representative: C. R. Olson, 1020—15th Street, Rockford, Ill.

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DURITE

For Victory

REQUIREMENTS for Planes, Tanks, Ships, Trucks, Tractors, Helmets, Bayonet Scabbards, Guns and other Ordnance must and shall have our first attention. Nothing within our power will be permitted to interfere with production and delivery for such purposes.

Because we are geared to the accelerated all-out production program, truly essential Civilian needs continue to receive our prompt attention.

DURITE and SERVICE are synonymous. DURITE invites you to submit your requirements for phenol-formaldehyde and phenol-furfural synthetic resins and compounds.

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DURITE PLASTICS

REG. U. S. PATENT OFFICE

FRANKFORD STATION, P.O. PHILADELPHIA, PA.

Looks Simple.. BUT, UNUSUAL ENGINEERING

PROBLEMS WERE INVOLVED IN THIS RADIO BEZEL FOR PHILCO

CURRENT Philco Radio Models feature an inclined bezel, injection molded by Sinko. At first glance, it looks like a simple molding job but that inclined feature required coring in two different directions . . both straight and at an angle. Ejecting the molding from the dies presented an engineering problem. Delayed action cores, designed by Sinko Engineers, proved a practical and successful solution.

Intricate Injection Moldings, including those requiring unusual metal reinforcing, have long been one of our highly developed specialties. Products and parts often considered impossible to produce by speedy, economical injection molding, have been completed successfully by our resourceful staff. You are invited, without obligation, to submit your ideas or problems to our experienced engineers. Call in our nearest representative or write us today!

Here's one of several Philco Radio Models on which the Inclined Bezel by Sinko is used. This new improved inclined horizontal dial is an attractive and practical feature . . visible evidence of the power of a Sinko molding to enhance the selling and merchandising effectiveness of a fine product. May we help you, also, with your molding problems?

Sinko

PRECISION INJECTION MOLDING

SINKO TOOL & MANUFACTURING COMPANY, 351 NO. CRAWFORD AVENUE, CHICAGO, ILLINOIS

REPRESENTATIVES: L.D. MOORE, 4030 CHOUTEAU AVE., ST. LOUIS, MO. • POTTER & DUGAN, INC., 29 WILKINSON ST., BUFFALO, N.Y. • ARCH MASON, 259 CENTRAL AVE., ROCHESTER, N.Y. H. O. ANDERSON, 202 HERALD BLDG., SYRACUSE, N.Y. • PAUL SEILER, 7779 CORTLAND AVE., DETROIT, MICH. • RALPH QUEISSER, 621 N. NOBLE ST., INDIANAPOLIS, IND.

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THE SUPERIOR ELECTRICAL PROPERTIES OF THIS PLASTIC MAY HELP YOU RIGHT NOW!

Beetle*is Available for All Essential Civilian and Wartime Applications

RIGHT NOW Beetle may provide the answer to your needs for a plastic combining excellent electrical properties with necessary physical characteristics.

CHECK THE TABLE and see for yourself how these properties compare with your requirements.

IN ADDITION Beetle, a thermo-setting plastic, has slow-burning rate, will not support combustion. It is not subject to cold flow and will not soften under heat.

FOR MORE INFORMATION, write us or get in touch with your molder. If you would like a copy of our handbook, BEETLE MOLDING MATERIALS, giving complete information, write us on your company letterhead.

*Reg. U. S. Pat. Off.

ELECTRICAL PROPERTIES

Arc Resistance (ASTM D-495—38T)—	120—180 seconds	
Power Factor and Dielectric Constant		
Low Frequency—60 Cycles—	Power Factor	Dielectric Constant
Temperature 25° C. (77° F.)	4.0—4.9	7.6—8.2
Temperature 60° C. (104° F.)	8.0—9.0	8.0—9.2
High Frequency—10^6 Cycles—		
After 48 hours at room temperature (75° F.) 60% R.H.	2.65—2.85	6.6—6.6
After 96 hours in water at 75° F.	6.24—7.55	10.6—11.6
Surface Resistivity—Megohms— (Electrical Testing Laboratory Report No. 138291)—		
After 48 hours at 60% relative humidity	3—10 x 10^6	
After 48 hours immersion in water	0.02—0.11 x 10^6	
Volume Resistivity—Megohms—Cm.— (Electrical Testing Laboratory Report No. 138291)—		
After 48 hours at 60% relative humidity	10^6—10^7	
After 24 hours immersion in water	10^5—10^6	
Dielectric Strength, Step-by-Step Method (ASTM D-149—38T)		
Thickness of section 0.000" 25° C. room temperature	300—385 volts per mil.	

PHYSICAL PROPERTIES

Tensile Strength— (ASTM D-48—33)	5,500—7,000 lbs. per sq. inch
Impact Strength, Dynstat 1.5 x 1.0 x 0.2 cm.	10-12 cm. kgs. per sq. cm.
Impact Strength, Charpy Unnotched bar 5" x ½" x ½"	1.2—1.4 ft. lbs.

AMERICAN CYANAMID COMPANY

PLASTICS DIVISION

30 ROCKEFELLER PLAZA • NEW YORK, N. Y.

Beetle and Melmac*

CYANAMID PLASTICS

MODERN PLASTICS
MAY 1942 VOLUME 19 NUMBER 9

G.E.M. PHOTO

The corporal of this squad wears his new "pot type" Army helmet with phenolic laminated liner. His companions are training in the old "basin type" helmet of World War days

The Army helmet liner

PROVIDING a soldier with two hats to be worn simultaneously is not precisely a new idea. The heavy helmet of the 13th century (which looked a little like an inverted iron cooking pot fitted in front with a piece of stove grating) was donned over a hood of mail or close-fitting steel cap when its wearer engaged in hand-to-hand combat.

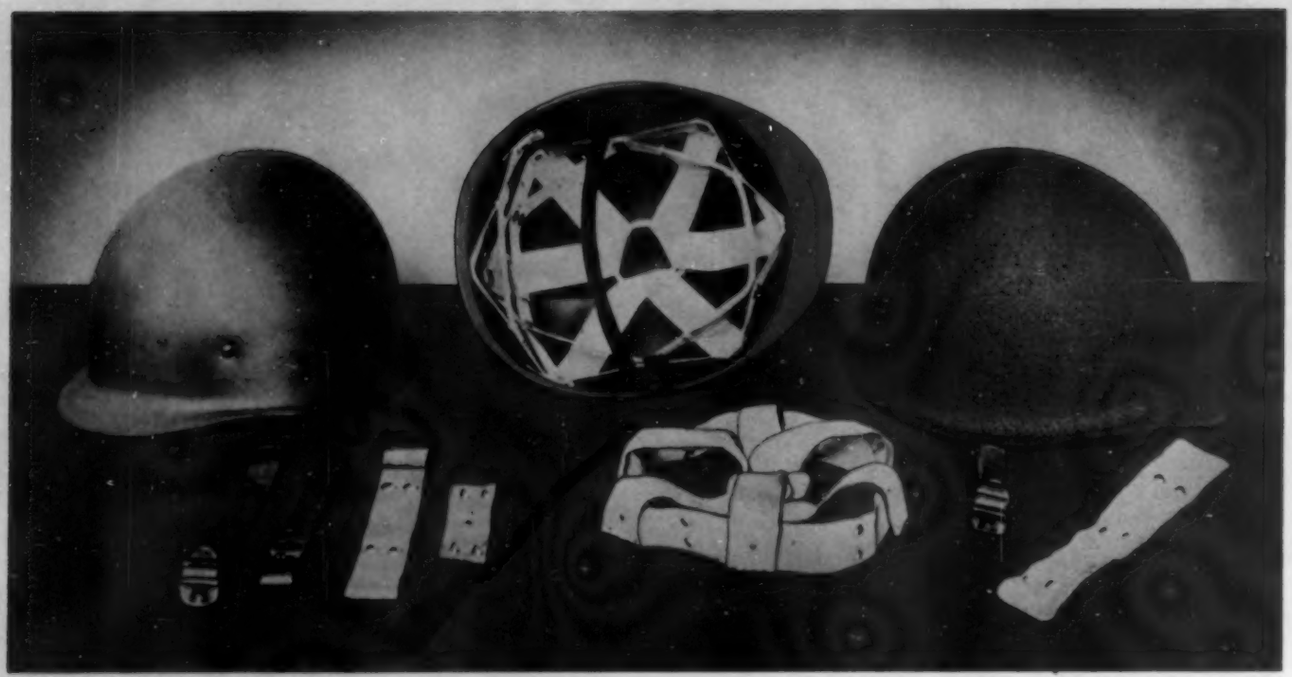
The word helmet itself, derived from the Old French, means "protection;" and from the time when the caveman swung at his adversary with a heavy club, some sort of protective head covering has been worn by the European soldier who fought at close quarters. When firearms and artillery superseded swords and crossbows, the helmet disappeared from the field of battle until the trench warfare of World War I brought it back into general use.

For some years the Army had used a fiber-felted, cloth-covered hat for tropical service. These hats were purposely designed in oversize head measurements to provide an air space which acted as a ventilator and rendered them exceptionally cool for use in hot or humid climates. They were light in weight and the suspension harness, consisting of wide woven tape covered with a leather sweat band where it came in contact with the forehead, was not uncomfortable.

It was decided to design for ordinary field service a light helmet of this type over which the steel helmet could be quickly slipped for actual combat wear. This called for an accurate sized liner because the snugness of its fit into the steel helmet was all that held the latter in place. Furthermore, these liners had to be sufficiently stable to retain their size under varying climatic conditions, otherwise the steel helmets would not fit them. Naturally, the liners would get most of their wear under non-combat conditions and would be subject to considerable field abuse. While these paper pulp, cloth-covered helmet liners did the job fairly well, it was thought that a stronger, more serviceable type of helmet could be developed by using plastic materials.

Samples of all types of plastic protective hats and helmets were secured by the Standardization Branch of the Office of the Quartermaster General and considered from the point of view of construction and material used. These samples included hats for miners and firemen, football, aviation and tank helmets and industrial helmets of various sorts.

At the request of the Standardization Branch, experimental work on this problem was undertaken by the Plastics Section of the National Bureau of Standards. Samples of helmet liners made from various plastic materials are subjected to laboratory tests to determine their resistance to conditions to which they would be exposed in service. These tests proved conclusively that the most serviceable phenolic



OFFICIAL PHOTOGRAPH, ORDNANCE DEPT., U. S. ARMY

2

3

INTERNATIONAL NEWS

***2**—At left is the new resin-coated fabric Army helmet liner as it will look when worn without the steel helmet. Interior view of liner shows suspension tapes, sweat band and chin strap (spread out in the foreground) riveted in place. Steel helmet (right) fits snugly over liner. **3**—Liner comes down well over the wearer's head, protecting his temples and the back of his neck. The entire twin-helmet assembly weighs approximately 3 lb.*

helmet liners obtainable commercially were not only too heavy but also did not have the required resistance to impact. It became apparent that the maximum degree of toughness would be obtained by using the smallest amount of resin which would give necessary waterproofness and dimensional stability to a fabric reinforcing material. It was also observed that, to a certain degree, the less the fabric was impregnated and compressed, the greater was the impact strength of the resulting product. It therefore became a problem of producing the highest impact liner material compatible with requirements for weight and resistance to delamination and deformation caused by swelling, shrinking or warping.

Gradually, detailed requirements were written into the specification. The fact that liners of thermoplastic material would not stand a sufficiently low temperature (minus 40 deg. F.) without becoming brittle and, furthermore, could not stand the delousing treatment (conducted at 253 deg. F. for 30 min.) eliminated them. Because of the light weight required in the liner (it must not exceed $7^{3}/_{4}$ oz. including outside coating, but without suspension tapes, rivets and chin strap, etc., or $11^{1}/_{4}$ oz. complete), the problem became one of finding the lightest reinforcement medium, coated or impregnated with a suitable thermosetting resin, which would give the required strength.

After considerable additional research and test work at the National Bureau of Standards, the material specifications were written up and read as follows: "Shall be made of laminated phenolic-resin-impregnated fabric, of substantially uniform density, coated on its exterior with a suitable olive drab finish." While this specification is very broad, the temperature (−40 to 160 deg. F.), relative humidity (range of 10 to 100 percent), and resistance to impact (15 ft.-lb. without fabric breaks, splintering or delamination of liner body) tests insure the use of satisfactory material. Several lots of experimental sample liners were ordered by the Standardization Branch and shipped to field depots representative of the range of climatic conditions likely to be encountered by our troops in all territories of operation. These liners gave such a good account of themselves that

detailed specifications for a phenolic laminated type of helmet were completed. The thinner walls dictated by the low weight specifications shortened the molding cycle, and the only remaining problem was the procurement of finished hardened steel dies ordinarily required for this type of molding.

During this experimental period the LeGrand Daly Co., synthetic rubber and plastic engineers, working in conjunction with the St. Clair Rubber Co., proposed a rather novel method of molding these liners. This process contemplated the use of a sheet steel helmet, slightly smaller than the standard steel helmet, for the female half or cavity of the mold, and of a soft heat-resistant bag made of synthetic rubber and lignin, capable of inflation to fit inside the cavity for the core. This method of molding permitted the production of a resin-coated fabric helmet liner with overlapping double thicknesses like structural ribs running radially from the trimmed edge to the crown. Helmet liners fabricated in this manner and molded under low pressure were found to withstand most tests, although not conforming in all details with the specifications. This procedure, while rather new in its field, definitely overcame the time element involved in making hardened steel dies, and promised quick production. Therefore, to supplement production of liners until high pressure type liners could get into production, a contract was placed with the St. Clair company and they began tooling for production.

The helmet liner molded by the Daly process incorporates a standard 8-oz. duck material 42 in. wide, conditioned for the proper moisture content and put through a conventional spreader which runs the fabric over liquid dispensing rolls. The use of a phenol-furfural resin conserves substantial quantities of critically needed phenol and formaldehyde. This operation is so controlled that the fabric receives a heavier coating of the phenolic resin on one side than on the other. The coated duck then goes through a dryer to modify the moisture and solvent content and to further condition it for molding, and is rolled up. Patterned segments which fit together to make the complete helmet are die-cut from this coated material. These segments are shaped like dumbbells and six of them, when placed in two layers in the heated shell form, overlap to form radial reinforcing ribs extending from the bottom edge of the helmet to the crown. The heavily coated side of the material will be on the inside of the finished helmet. For the forming operation, the die-cut pieces are first assembled in layers in semi-heated vessels to speed forming and to pre-heat the material for the actual molding operation. The pieces cement themselves together slightly, thus eliminating the need for any stitching operation. From these vessels, the pre-formed helmets are removed to the die cavities.

The die cavity, as previously mentioned, consists of a stamped and drawn steel helmet slightly smaller than the standard steel job, supported in a steel casting of the same shape, which is jacketed for steam circulation during the molding cycle. The soft synthetic rubber bag ($^1/_4$ in. thick and smaller by about $^1/_4$ in. than the inside dimensions of the hat) used as a core, or male half of the die, is then placed in the pre-formed helmet within the supported heated steel cavity, and the whole assembly of die and part clamped so that it will readily stand the 110 lb. of steam pressure which is forced into the rubber bag. The bag expands, and applies uniform pressure to the laminated material. The liner is cured in this manner for approximately 10 minutes before the rubber bag core is removed, the liner taken from the steel shell, and its lower edge trimmed to the proper contours and sealed. The liner then goes through an automatic spraying machine which coats both the inside and the outside with a synthetic resin lacquer in the characteristic olive drab Army color. The sprayed helmet liner is then baked for six minutes in an oven to give it a dull finish which prevents any possible light reflection and renders it non-marring. The wall thickness of the finished liner is approximately .032 in. around the bottom, .064 in. in the ribs and dome.

After the helmet liner is carefully inspected, the head suspension (which comes in 15 different head sizes) is riveted to the inside with rivet heads all on the outside, where their contact with the steel helmet provides a firm, snug fit when the two are worn together. (*Please turn to next page*)

4, 5—***Dumbell-shaped segments of resin-coated duck are inspected and laid up in preforming vessels, where they are preheated and cement themselves slightly together***

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6—The preformed liner is placed in the die cavity, molded under 110 lb. of steam pressure for 10 minutes. 7—Finishing operations consist of trimming and sealing liner's edge, spraying it with synthetic resin lacquer, baking it

For some time there have been two definite schools of thought within the plastics industry regarding the most desirable pressures for molding laminated phenolic impregnated or coated materials to secure the most satisfactory products. The advocates for low pressure work, as used in the helmet liner made by the Daly process, maintain that woven cloth fibers with the proper moisture content, when coated with a suitable phenolic resin and molded under a pressure of approximately 110 lb. per sq. in., yield structural characteristics that are superior to those of the same parts molded under high pressures (1500–2000 lb. per sq. in.). They reason that these higher pressures tend to break down the individual fibers in the woven fabric so that its initial strength is not retained. In other words, under low pressure each individual fiber or strand keeps its individual strength because it is not displaced or distorted as it is thought to be under high pressures. For low-pressure molding, the woven fabric or duck is merely coated and subjected to no force which might segregate or distort the fibers. Since the molding process is carried on under low pressure, it also occasions no displacement of fibers. The original strength of the fabric is thus retained, and the necessary bond and stiffness are contributed by the polymerized resin.

Advocates of the high-pressure method contend that with hardened steel dies used both for cavity and for core, a more homogeneous, tightly compressed, uniform molding results. Furthermore, the molding cycle is shorter due to the more rapid transfer of heat from the heated steel dies to the parts to be molded. It is conceded that, with the use of steel dies and high pressure, more care must be exercised in forming to secure a uniform wall thickness. Should the wall thickness be non-uniform or uneven, the high pressures might tend to rupture or destroy the fibers in the fabric, thereby weakening the assembly.

When all research is completed it will undoubtedly be found that both high- and low-pressure methods have their proper places, dependent on the job at hand. If, on the other hand, low pressures are possible and even advantageous for some laminated plastic parts, as the Daly method indicates, new and important fields for such a molding process may be opened up. Lower tooling costs and speedy tool manufacture are especially desirable factors in these days. An additional advantage of the method is the use of the synthetic rubber bag core, which enables parts to be molded under uniform pressures even though the wall thicknesses may vary considerably.

Other contracts for laminated phenolic impregnated helmets have been placed with Inland Manufacturing Co., Mine Safety Appliances Co. and Westinghouse Electric and Mfg. Co. It is understood that these will be produced by the orthodox high-pressure, hardened steel die procedure, and production is scheduled to start soon.

These laminated plastic liners, designated by the Army as Helmet Liner M-1, are so snappy and military-appearing that they will be issued "in lieu of other headgear" for wear by soldiers on duty in camp and field, with the addition of distinctive insignia when desired. Tests indicate that these liners, despite their light weight, when worn without the steel helmets offer considerable protection against stones, small missiles or débris thrown by bomb explosions. A special lining with ear flaps has been developed for use inside the liner for cold weather.

LINER, HELMET, M-1

The following are extracts from the Quartermaster Corps' tentative specifications for a helmet liner, issued Feb. 13, 1942:

E. Detail Requirements

E-1. The liner, helmet, M-1, shall conform to the following detail requirements when tested within a temperature range of −40 deg. F. to 160 deg. F. and relative humidity range of 10 to 95 percent.

E-1a. Shall fit snugly without forcing into, and shall have minimum rattle and vibration when worn with the helmet, steel, M-1, "A," and shall be capable of being inserted with reasonable hand force into sample helmet, steel, M-1, "B." Both samples are to be furnished the contractor by the contracting officer. (*Please turn to page 104*)

Plotting the course

With compact, lightweight sextants in their hands, celestial navigators steer their swift new planes by the same old stars

PHOTOS, COURTESY LINK AVIATION DEVICES, INC.

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NAVIGATORS, whether of ships of the sea or ships of the air, plot and check their courses by the sun or stars with a device known as a sextant. This instrument, which measures angular distances, is used for observing altitudes and from them calculating latitude and longitude. The supreme importance of aircraft in modern warfare has dictated the redesign and improvement of aerial navigation instruments, the sextant among them.

For use by the Army, Navy, commercial airlines and schools teaching celestial navigation, Link Aviation Devices, Inc., has developed a new bubble sextant incorporating two ingenious applications of plastics. Both contribute to the essential qualities which an instrument of this type should possess: light weight, compactness, mechanical simplicity, correct balance in the user's hand and adaptability to quantity production.

Urea-formaldehyde is molded to form the recording drum (light-colored disk, Fig. 3), which is geared to the arm carrying the vernier, or short scale, and drives it along the 90 deg. scale at the lower edge of the instrument. The navigator's observations are recorded with pencil on the surface of the drum. It is detachable, and several are furnished with each sextant so that readings from individual stars may be recorded on separate drums. Later, by replacing the drums on the sextant, the navigator may take his median reading.

Because of its texture and light color, the plastic drum takes the recording marks readily, and they are easily rubbed off when they have served their purpose. An electric bulb inside the sextant throws enough light through the translucent urea-formaldehyde to make the pencil marks discernible. The plastic is extremely lightweight, a factor which contributed to its selection for a device to be held in the hand. Unaffected by temperature or wet weather, it is mechanically strong, inexpensive, and adds to the sextant's appearance.

In earlier sextant models, a second light bulb was mounted at the end of the arm to illuminate the vernier and arc and thus facilitate the taking of readings in darkness. This cumbersome arrangement, which added to the net weight of the instrument and put an additional drain on its small battery, was dispensed with by running a bent rod of methyl methacrylate along the arm (Fig. 2). This clear plastic has the unusual property of carrying light around curves, and here transmits illumination from the bulb that lights the drum to the vernier and 90 deg. scale.

In addition, use of the methyl methacrylate simplifies the design of the sextant, makes it more compact, and deducts from its weight.

Credits — Material: Drum, Plaskon, molded by Auburn Button Works, Inc.; rod, Lucite.

***1**—The well-balanced sextant fits comfortably into the navigator's hand, its light weight minimizing muscular exertion. **2**—A methyl methacrylate rod carries light from a central bulb, throws it on vernier and arc at outer edge of sextant. **3**—Recordings are marked in pencil on the light-colored urea-formaldehyde drum, are easily erased*

Sweeping in thermoplastics

by H. R. HUSTED*

Achievements in injection molded vacuum cleaner housings and accessories point to postwar changes in the sweeper industry

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PHOTOS, COURTESY TENNESSEE EASTMAN CORP.

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TO EFFECT complete conversion to war production, the vacuum cleaner industry on April 30, 1942, joined others in the consumers' durable goods field whose facilities were being concentrated on the manufacture of war supplies. Thus a remarkable story of design, engineering and material development, in which plastics play a stellar role, stops practically at the climax, until the postwar stage is set.

A few short years ago the principal castings for vacuum cleaners were made of cast iron or bronze. The large floor casting was a cast iron shell, painted with a baked enamel. Small attachments were of cast bronze, polished, painted or plated. Aluminum was then substituted because of its lightness and ease of fabrication, as in sand casting and die casting. In 1936, a radical change in material made vacuum cleaner news—molded phenolic was introduced by one manufacturer for a streamlined motor housing and for 10 other molded parts.[1] By 1941, phenolics were used for as many parts as possible in succeeding models and other vacuum cleaner manufacturers, aware of the great savings in weight and facility of design permitted by plastics, had meanwhile followed suit. In fact, in 1941 an all-plastic hand or floor cleaner made of four molded pieces was introduced.[2]

Simultaneously, thermoplastics entered the field. Such articles as knobs, buttons, handles and small nozzles were made of cellulose acetate and cellulose acetate butyrate. The nozzle was a particularly interesting development, as the part to be molded had a rather long draw with cores moving at approximately 120 deg. angles. The finished product

* Plant Superintendent, Zenith Plastics, Inc.
[1] MODERN PLASTICS, Nov. 1936, p. 32.
[2] MODERN PLASTICS, Aug. 1941, p. 42.

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had to withstand shock and impact; and could not shrink beyond the given tolerances because the nozzle had to fit into a tube. Nozzles were produced which filled these requirements and were widely accepted because of their colorfastness, and their smooth surface which did not mar, scratch or scuff woodwork, wallpaper, upholstery or linoleum.

But even this did not bring injection molded vacuum cleaner parts into prominent use until an acute shortage of aluminum was foreseen, and until subsequent restrictions on phenol and formaldehyde made vacuum cleaner engineers and designers focus on the then more available thermoplastics. Starting with accessories, they developed nozzles and brush holders, crevice tools and finally small motor housings for hand cleaners in thermoplastics. This achieved immense weight savings, made possible the rapid economical production and assembly of complicated shapes and permitted a huge range of colors.

Thermoplastics early appeared on tank-type floor cleaners in the molded bell or flange which is the dome used at both ends of such cleaners. A flange of cellulose acetate butyrate was designed for a recent model cleaner. It measures about 8 in. high, $1^1/_2$ in. in diameter at top, increasing to 9 in. in diameter at the bottom, with a heavy bead 1 in. from the bottom. On the top, inside, is a large boss, grooved to hold a tube. The heavy bead near the bottom, the thin walls in the center and the thick boss at the top presented a tricky shrinkage control problem. The wall sections of the flange had to be heavy enough to withstand the bumping and scraping that it would receive as the cleaner was pulled across the floor; but for economy's sake, the walls had to be held to a minimum thickness and kept as uniform as possible.

Attachments for this tank type cleaner include a large floor nozzle, several small nozzles and a "library" brush which has bristles attached for dusting books, draperies, etc. The large nozzle (Fig. 11), 11 in. wide, is of cellulose acetate butyrate and was molded entirely off the centerline of the mold. This was necessary because the part had to be gated on the front lip, and the core for the tapered hole in the shank had to pull upward to clear the piece. The molder had to see that the die did not flash under any conditions or the taper of the shank would have been changed and the nozzle rendered useless. By reducing the cross sectional area of the nozzle, nozzle suction was improved. This nozzle and others in the set are used on a swivel also molded of cellulose acetate butyrate (Fig. 10). This swivel is tapered $^1/_{10}$ in. per in., as is the inside of the nozzle shank, so that these surfaces meet perfectly to give a complete seal and thus maintain the highest

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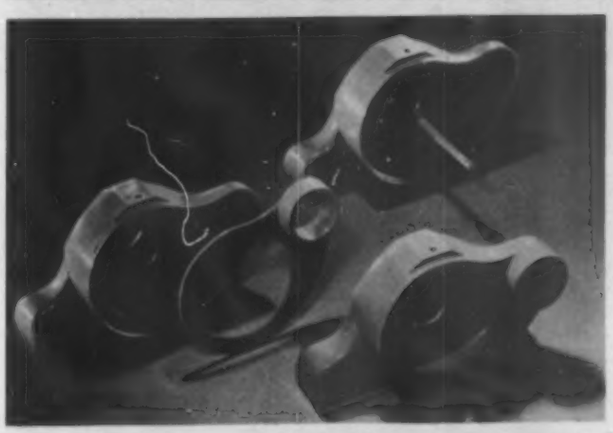

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***1**—Conserving strong-arm power for war work, lightweight cellulose acetate butyrate hand vacuum sweepers make housecleaning a less strenuous chore.* **2**—*Close-up of the Royal sweeper showing the smooth, colorful molded plastic housing, trim and efficient.* **3**—*Royal housing and matching molded plastic attachments, which won't scratch furniture or walls, are easy to handle.* **4**—*Premier hand cleaner has a wide case and is reinforced by a metal ring and a back plate.* **5**—*Assembly of the Premier, showing housing as it comes from the press (upper right) and with metal plate in place (left). Back plate is in front of it. Complete unit is at lower right.* **6, 7**—*Front and rear view of the Premier 16-oz. floor sweeper housing. This large nozzle, 13 in. long and $2^1/_8$ in. wide, was made in two sections cemented together and then buffed. Overall height with top is 6 in.*

vacuum. The shrinkage had to be calculated in the die and the molding in order to obtain and hold the proper dimensions in the finished part.

The library brush included in the equipment, a small accessory for collecting dust, etc., has a cellulose acetate shank 3 in. long, the core of which meets the bottom core at a 90 deg. angle. The short core is on the bottom or stationary half of the mold and the long shank cores are lifted by cams as the die opens. The part is then screwed to a brush.

One vacuum cleaner manufacturer is now supplying a hand cleaner with each floor sweeper sold. The injection molded thermoplastic hand cleaner is light, sturdy and very comfortable to handle. It has a revolving brush in the nozzle, just as the larger floor type sweeper has, making it possible to do a very efficient job of cleaning furniture, small rugs, draperies, spreads, etc. The primary duty of this brush is to lift the nap of the rug and loosen the dirt that will be drawn into the bag. The revolving brush, located in the bottom or nozzle of the housing, is driven by a rubber belt which in turn is operated by a high speed motor, usually weighing slightly more than a pound. Therefore this cleaner and the other two hand cleaners discussed below, all of which have similar revolving brushes and motors, are considerably less fatiguing to operate than floor models.

However, since the rubber belt which drives the brush has a pull of approximately 13 lbs., the plastic parts had to be designed to resist any tendency to warp or twist. These heavier sections, often located near thin walls, were a molding hazard because of possible sinks or shrinkage. By careful ribbing and the addition of the proper radii and fillets, such shrinkage was controlled.

Two other hand cleaners molded of cellulose acetate butyrate which are the same in principle but slightly different in construction are the sweepers illustrated in Figs. 1-5. The first, the lighter of the two, weighs approximately 4 oz. and has a narrow case not over $4^1/_2$ in. high (Fig. 2). The other cleaner has a main casting weighing about $6^1/_2$ oz. and a back plate which weighs $1^1/_2$ oz. The difference in design accounts for its greater weight.

Two parts—the main casting and back plate—cemented together in a unique fashion are required for the cleaner shown in Fig. 4, since it would be impossible to make the unit in one piece. The back plate was not strong enough to support the weight of the motor and bag so a metal plate was designed to be cemented between the main casting or nozzle and the back plate (Fig. 5). This steel plate or ring about $^1/_{12}$ in. thick is thoroughly hidden in the final piece. The steel ring has four lugs which are forced into small slots, pierced through the back edge of the fan chamber while the plastic is still warm and flexible. It is cemented firmly and after the cement has dried, the joints are wet sanded, pumiced and polished. Most of the screw or bolt holes have been cored in the castings, and with the aid of self-tapping screws the sweeper is comparatively easy to assemble. The result is a sturdy cleaner incorporating the colorful beauty of plastic with the strength of steel.

Another small plastic hand sweeper was made as an exact duplicate of its former aluminum die casting. It has a tubular handle 4 in. long and a rather deep fan chamber for the entrance of a large volume of indrawn air. This cleaner has five under-cuts that had formerly been molded by the use of loose inserts; but by utilizing the flexibility of thermoplastic materials which soften under heat and by using unique core movements, the molder was able to mold this piece with-

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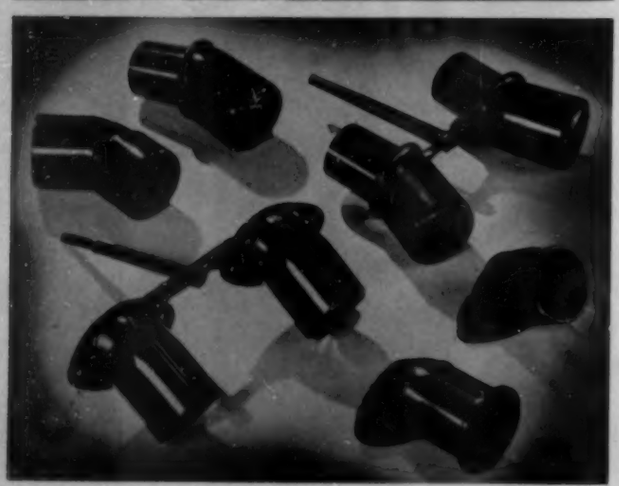

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***8**—Kenmore molded motor dome is streamlined for looks and service. The tough plastic housing resists the heat of the motor and of the pilot light. Note the light window in front, countersunk screw holes in either side and side ventilating louvers. Note the long 9-in. sprue on the inside.* ***9**—Close-up of the Apex swivels in the press just after the molding cycle has been completed.* ***10**—Tapered molded swivels and brush holders are injection molded to close tolerances to fit snugly inside the nozzle shank so there will be a complete seal between nozzle and handle to maintain perfect vacuum. These are all of cellulose acetate butyrate*

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11—*Injection molded cellulose butyrate nozzle (top) measuring 11 in. wide is one of the attachments for the Apex tank type cleaner. Rear view of the nozzle (center) shows the complex construction. Kenmore 8 in. floor nozzle is at bottom.* **12**—*Apex vacuum sweeper attachment is similarly molded. These plastic parts are lighter than metal and have a tough but non-abrasive surface*

out the use of loose cores. The handle core is moved by a horn or angle pin as the die is opened, and clears just as the ejector pins strike the piece. One undercut measuring $1^1/_2$ in. long by 2 in. wide is made by an ejector pin. The piece is lifted off the cores and then slid to one side, removing it from the now raised undercut core.

Thermoplastics, as a result of the successful hand cleaners, have also been specified for a large floor-type vacuum cleaner. It has a molded hood or dome mounted on the top of the large sweeper casting (Fig. 8). The plastic had to withstand the heat of the motor and that of the pilot light mounted on the front. This dome is an extremely interesting part as it has a light window in the front, two countersunk screw holes on the bottom of either side and ventilating louvers on the sides. It measures $9^1/_4$ in. long by $5^3/_4$ in. wide and is about 5 in. high. It weighs about 7 oz. The mold for this piece measures 16 in. wide, 24 in. long and 14 in. thick. The moving mechanisms to pull the cores on the louvers constitute the sides of mold, and measure 16 in. by 12 in. each and are moved up and down automatically as the die is opened. The sprue is 9 in. long and shoots through the core to the inside of the dome. The dome has been made in two styles one of which is shown in Fig. 8.

As may be seen from the above descriptions, molding of thermoplastic vacuum cleaner parts involves highly complicated molds, because the majority of the parts must be molded with at least one sliding or moving core. In molding the parts shown, the molder used racks, pinions, slides and angle pins quite freely. The hand cleaner housing, the large domes and the tank-type flange were molded on a 12-oz. press; the floor nozzle on a 9-oz. press and smaller parts on both 7 and 4-oz. presses. A single cavity mold was built for the hand cleaner housings and other large pieces.

Most of the smaller nozzles and accessories were molded in two-cavity molds built contrary to conventional designs—that is, off-center. In these molds, the cores move away from the center of the mold in a vertical line. The angle formed by the meeting of the sliding and stationary cores is 120 deg., these providing cored openings which permit attachment to be handled with a minimum of effort. The pressure exerted by the closing cams must be very high and positive as there must not be any flash or fins on the inside of the pieces to impede the flow of air into the cleaner, or to snag lint and threads, thus blocking the tube and reducing the efficiency of the sweeper.

Routine molding practice of equalizing the pressure of the molding materials in the center of the plattens is abandoned in order to simplify die construction and avoid extra finishing problems. The dies are designed so that the pull cores operate in the same vertical direction and are parallel to the plattens. To reduce the size of the molds, round angle pins slide in bored, lapped holes in the core blocks, yielding positive action and close machined tolerances.

One very interesting molding job is a cellulose acetate crevice tool 10 in. long, $1^1/_2$ in. in diameter, said to be one of the longest draws ever molded by the injection method. This die uses the rack and pinion principle for its mechanical action. The mold for this piece is 16 in. wide, 12 in. thick and 44 in. long, extending 20 in. above the platten. The cores move on a pinion as the die opens, drawing up 10 in. and clearing the piece just as the ejector pins hit the article. And this four-cavity mold is automatic!

All of these plastics parts are carefully polished and trimmed, if they need it, before final inspection and packing.

Beyond the advance in design, the workmanship which these vacuum cleaner parts represent is the evidence of a remarkable substitution of thermoplastic materials for metal, rubber and even for molded phenolic, now an essential war material. The ultimate result of this engineering and molding achievement will be seen after the war, when American designers, molders and engineers will be free once again to concentrate on the "home" front.

Credits—Material: Tenite I and Tenite II, molded by Zenith Plastics, Inc.

Shipping and storing extrusions

WITHIN the past few years extruded plastic trims and moldings have rapidly moved into the architectural, building, furniture and a variety of other fields where decorative protective edgings are used. Since, unlike custom molded or fabricated plastic pieces, most extruded shapes are available from stock, extruders have had to consider methods of shipping these stock shapes that allow them to be handled efficiently and, in addition, to be stored conveniently in shops and warehouses. Large boxes are generally used; but one manufacturer has developed a unique container—a spirally wound fiber tube—which not only prevents damage to the surface, prevents bending or distortion of the 10 ft. (or longer) extruded strips and protects the shape of intricate cross sections, but also affords an excellent means of storing stock (Fig. 1).

Developed after considerable experimentation, these fiber tubes are made according to specifications worked out by the plastics manufacturer. Tubes range in diameter from 1 in. to 6 in. and are of varying thicknesses and constructions to accommodate the specific needs of differently sized and shaped extrusions. They are said to withstand the stresses and strains of being stacked in piles, exposed to dampness, thrown off moving trucks, etc. In addition, the packaging helps to modify the effect of winter weather on the thermoplastic material, since cold air tends to make the plastic brittle. However in cold weather, extrusions should be kept at room temperature at least 24 hours before using.

The spirally wound tape around the outside of the tube serves the dual purpose of identification and labeling. The manufacturer's name is repeated over the length of the container, as is the instruction to "handle the tube from the center." Additional indentification labels affixed to the center of the container show the name, color, size and quantity of the product in the tube. There is space for a key number to indicate to the factory the date of packing and the numbers of the inspector and packer, so that in case of any complaint or reject, the difficulty can be traced to its source.

As shown in Fig. 2, the extruded moldings fit snugly inside the containers so that they cannot be tossed about in transit. After the extruded pieces are in place, so arranged that they can't rattle or twist, instruction sheets for installation together with individual envelopes of nails are inserted. Ends of the tube are stuffed with paper to absorb shocks, and wooden stoppers or "bungs" driven into them.

Since these tubes occupy little space, the distributor or retailer can keep a large stock on hand, arranged according to style, color and size for ease of selection.

Credits—Extrudings and containers developed by R. D. Werner Co., Inc. Plastic material: Lumarith.

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PHOTOS, COURTESY CELANESE CELLULOID CORP.

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1—Row on row of fiber containers filled with extruded plastic lengths now stand where aluminum moldings once gleamed. Note the spirally wound label and identification tape pasted on center of tubes. 2—Close-up of end of fiber tubes showing extruded moldings packed snugly so they won't slide. Instruction sheets and nails are included in the tube. Wooden bung (right) is used as the stopper

★ ★ ★ Industry Prepares for War Rôle ★ ★ ★

THE fighting spirit of American industry united in a common cooperative effort to help win the war for existence, coupled with the awareness of the increasingly important rôle of plastics in this gigantic struggle, dominated the annual spring meeting of the Society of the Plastics Industry, held May 3, 4 and 5, at the Homestead Hotel, Hot Springs, Va. Over 275 were in attendance, including plastics materials suppliers, manufacturers, machinery and tool makers from every section of the United States and from Canada, and Government technical representatives from the armed services.

Democracy on the offensive in the voluntary enlistment of the industry for all-out plastics aid in the war program was evidenced in two militant plans of action resolved upon by the Society. First, as outlined in the speech by Henry Sang of the Naval Aircraft Factory (see below), it was proposed to help accelerate the use of plastics in aircraft by collecting and coordinating all aircraft engineering, design and technical information available through a Government sponsored committee. This committee is to be part of the present A.N.C. subcommittee on wood structures with increased membership to include representatives of the Army, Navy, Civil Aeronautics Authority, plastics industry and aircraft industry, which will cooperate with the National Bureau of Standards and the Forest Products Laboratory. This committee is intended to help speed the aircraft production program and avoid duplication of effort in the research, testing and assembling and standardizing essential plastics engineering data.

RONALD KINNEAR, S.P.I. PRESIDENT

Secondly, a resolution was discussed to form a special Plastics Planning Board which would determine what plastics will be required in the war program, how many plastics and chemical plants will be necessary to supply these plastics, how to put idle capacity to work and also to help the Army, Navy and WPB find plastics for war materials and for civilian essentials. This plan was inspired by an address delivered by Charles A. Higgins, President of Hercules Powder Co., which is detailed below.

Stimulating informative addresses were delivered at the banquet and open sessions of convention by Sir Henry Self, Director General of the British Air Commission and civil member of the Combined Staffs; Senator Harry S. Truman of Missouri, Chairman of the Special Defense Committee to investigate the National Defense Program; Dr. Gordon M. Kline, Chief, Organic Plastics Division, National Bureau of Standards and Chairman of the Federal Specifications Executive Committee on Plastics; William Haynes, author of "This Chemical Age," and Frank W. Warner, Chairman, S.P.I. Technical Committee. In addition, at the sectional and business meetings, members discussed vital technical problems regarding materials manufacture, specifications, supply of basic chemicals, machinery, pertinent industrial problems, and conferred with technicians of the armed services. A complete summary of the various sessions and detailed reports of the important addresses delivered at the meeting, lists of new officers, etc., follow in this special MODERN PLASTICS report.

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At the opening session of the S.P.I. Convention on Monday morning, May 4, 1942, Ronald Kinnear greeted the members and stressed the responsibilities of the industry in maintaining the American traditions. "Personal gain must be relegated to a secondary position for the duration," Mr. Kinnear stated. "In the long run, those policies which most soundly serve the public interest are the ones which will make the greatest contribution to the industry's progress and standing." Mr. Kinnear also announced that the Bureau of Ordnance of the United States Navy had sent representatives to discuss many new highly technical proposed applications with industry members, and stated many of the speakers would review questions involving application or potential uses of plastics in war work.

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First of these speakers, as mentioned above, was Henry Sang, aircraft engineer of the Naval Aircraft Factory, whose paper on "Technical Problems of Applying Plastics and Allied Products in Naval Aircraft" is herewith presented in full:

I notice that this talk is programmed as a discussion of present and proposed plastic applications in aircraft and a description of the N.A.F. work. In a sense that is what the Navy wishes to present on this occasion. On the other hand, we are conscious of the fact that we have been merely discussing and describing plastics for quite a long time—too long, in fact. At this time, therefore, following discussions with your Society, about which you have heard, and following other tentative agreements between Government and industry representatives, we present in broad outline a plan of action, including a summary of the situation at the moment and of the plans that we have laid for immediate acceleration of the plastics program. We want to get down to business.

I am speaking for the Navy Department, Bureau of Aeronautics. However, as will be explained later in my talk, this program is to be sponsored by the Government—that is, the Army, Navy and Civil Aeronautics bureaus. This means that the problems of engineering and supply, etc., are now confronting us not with relation to a possible future program but with relation to a program that is a reality.

There is no question as to the principal reason for the current importance of plastics and wood in the aircraft program. It is simply that alternate materials must be found to use in place of strategic metals and strategic metal parts—that is, parts such as forgings that constitute or will soon constitute time bottlenecks because of lack of tools or machinery to produce them. But above and beyond the goal of achieving scheduled production rates by the immediate use of certain alternate materials is the even higher goal of *increasing* that production rate by a truly comprehensive program involving the wide use of all possible alternate materials. We realize that certain alternate materials will soon be strategic but we wish to use all alternate materials to the limit of their availability. While the Government and the aircraft industry are vitally concerned, the burden of effort must lie on the shoulders of the plastics industry. It is up to you to explain the merits of your products to us in our language,

to tell us what is good and what is bad, what is available and how much of it and all the basic information involved in planning for extensive engineering design changes. It is the purpose of this talk to present our views on how this can be accomplished and to explain our part and your part in the program.

The Navy's policy has been to group plastics, plywood and adhesives together, since they are all involved in the problem of alternate materials. For example, the resins used to bond plywood, or used in the manufacture of "compreg" and the adhesives that appear to be important in the fabrication of composite structures—that is, to join metal to wood, metal to plattic, etc. When we refer to alternate materials in general, therefore, we mean plastics, plywood and adhesives and our words are addressed to all concerned with those products.

HENRY SANG

We wish to stress this broad approach to the alternate materials problem in aircraft because we believe it to be vital to the success of the program. We have already informed the technical committee of the Society that we are concerned with this broad picture and that we wish to deal with an engineering group representing in the fullest possible manner not only the molders and the suppliers of raw materials but also the laminators, the manufacturers of plywood specialties and certain other groups such as the glass industry who have done valuable pioneer work in plastics, plywood and adhesives. We believe that you will agree that there are so many interrelated phases of the developments within these groups that it would only result in confusion for the Government to attempt to negotiate with each one separately. For this reason it is proposed that the Plastics Industry Committee representation consist of members of the S.P.I., NEMA, laminators and all the other groups concerned.

But let us go over the background leading up to our discussion. The first task confronting the Government was, of course, to become acquainted with the new materials—materials which had previousiy had no engineering uses related to aircraft and whose engineering properties were to a large extent undetermined. This fact of an almost complete lack of engineering background coupled with the corresponding lack of engineering personnel in the plastics industry has resulted in a prejudicial attitude on the part of both prospective users and prospective suppliers.

With certain outstanding *exceptions*, therefore, the field of plastic applications in aircraft has lain almost untouched. In the meantime the Government, through its bureaus and laboratories, has made the acquaintance of the plastics industry, has explained to it the general problems and has received and tested hundreds of different materials and a few experimental aircraft parts. It has attempted also to stimulate interest in new processes for producing plastic parts in limited quantities at a reasonable cost.

While this program has met with reasonable success, some progress having been made in all phases, it became increasingly obvious to Government engineers that there were too many separate threads of investigation and too many separate obstacles. Some of the successes attained seemed accidental. In general, a complete reorganization of effort was required in order that the goal might be approached directly instead of by many devious paths. Then, again, the advent of actual warfare brought the whole question of plastics to a head. It was evident that we needed a liberal injection of Vitamin "V."

There followed the decision to request the cooperation of the S.P.I. to an extent far beyond its normal scope of activities, in an effort to bring the Government's aircraft problems before the industry as a whole instead of separately to many different manufacturers. It was felt that the basic problem of placing plastics on an engineering basis could best be accomplished through a central Government-industry committee. This Government group will know what is being done and what new developments are desired. Through it, or with its knowledge, the Government will make its desires known to groups representing the plastics industry, thus providing a double check to prevent duplication of effort. Having obtained the technical advice of the industry committees, the Government will then take the necessary action.

At the same time, the Government bureaus and laboratories will accelerate the program of testing materials and parts so that approval of the alternate parts can be accomplished as rapidly as possible.

We are sorry not to be able to present at this time the comments and plans for cooperation of the aircraft industry on the proposed program. It can be stated, however, that the closest coordination between the Government and the plastics and aircraft industries will be maintained. I have spoken in the last few days with an official of a large aircraft concern, whose company is interested in using plastics for a large number of parts on one of its production types. He has been carrying a large bundle of blueprints about from one plastic manufacturer to another. His job will be made much easier when the central committee is in operation. There are several other companies anxious to use plastics in volume. Many companies are hesitant.

It is within the power of the Government to enforce the use of alternate materials for specified parts, and this policy will be adopted whenever it appears necessary. However, the hesitancy on the part of aircraft manufacturers to employ alternate materials will be removed to a large extent by the clarification of the Government's attitude toward such procedure and the knowledge that the plastics industry is working as a unit to supply the necessary facts and data.

I wish to announce at this time that negotiations toward the forming of the plastics committee are well under way. I will read a teletype message received from the Bureau of Aeronautics on May 2nd by Lt. Comdr. Scoles, of the Naval Aircraft Factory:

REF. YR LETR 29 AP 42 SUBJ. DEV OF PLASTICS. THE AERONAUTICAL BOARD AUTHORIZES AN ANNOUNCEMENT BY NAVY REPRESENTATIVES AT ANNUAL MEETING OF SPI AT HOT SPRINGS VA STARTING 4 MAY 42 THAT THE INFORMATION TO BE COLLECTED UNDER THE PROPOSED COOPERATIVE PROGRAM WILL BE OFFICIALLY PUBLISHED AS GOVERNMENT DOCUMENTS AS PARTS OF APPLICABLE ANC BULLETINS ON AIRCRAFT DESIGN CRITERIA. The import of this message is broad.

The letter referred to was signed by Lt. Comdr. Scoles. In it, it was proposed that the present ANC sub-committee on wood structures be made also a sub-committee on plastics, with increased membership to include representatives of the Army, Navy, Civil, Aeronautics Authority, plastics industry and aircraft industry. Methods of coordination with important Government agencies such as the Bureau of Standards and Forest Products Laboratory must be decided upon.

Now, all the questions that the plastics industry wishes to ask about aircraft, and all the questions that the aircraft industry wishes to ask about plastics will be referred to this committee. There will not be 3 or 4 different answers to each question as there have been in the past.

The most direct way to present the part to be played by the plastics industry is to outline to you what we want, what we think you have available for immediate use and what you have that is potentially useful.

There are, in general, three ways in which plastics may be used in aircraft:

1. *Substitutes* where the plastic is inferior to the metal part but gives adequate performance in an emergency. It may be heavier, less durable, or may have an unpleasant odor.

2. *Alternates* where the plastic appears to be equal to the metal or where it is better but more costly or slower in production.

3. *Replacements* where the plastic is superior to the metal in cost and performance.

Two important factors must be considered:

1. Whether strict dimensional interchangeability is required, or

2. Whether a new design based upon plastics is desired.

Obviously strict interchangeability is required in changing to plastics in present production of aircraft. This calls for great ingenuity on the part of the designer and it can only be accomplished by close cooperation between the plastics and aircraft engineers.

When, however, the design is to be based upon the use of plastics only, the important thing is to make the decisions while the airplane is still in the design or experimental stage. That is why we may expect a larger number of successful applications on new production aircraft, and why it is important that the new designs be investigated immediately with the idea of making the largest possible number of parts out of alternate materials.

Now, as to the types of parts that we are considering for this program:

1. *Injection and transfer molded* parts, such as knobs, handles, nameplates, fittings and housings.

2. *Extruded parts*, such as tubing.

3. *Compression molded parts*, such as spinners, covers, boxes, pulleys and wheels and propellers.

4. *Fabricated* parts, such as machined fittings and stampings of fiber or laminates.

5. *Built-up molded* parts, such as tabs, seats, fairings, doors, flooring, ducts and tubing.

6. *Textile* parts, such as fabrics, ropes, lines and screens.

7. *Formed* parts, such as transparent enclosures and domes.

We are purposely avoiding reading a long list of specific parts. We wish to attack this problem with a minimum of talk and a maximum of action and for that reason the best way to present this list of parts will be to arrange a formal exhibition at an aircraft plant of actual metal parts from a modern airplane. We are therefore planning to dissect such an airplane with the cooperation of the aircraft industry, and bring your committees to see this airplane. We wish you to see all these parts with relation to the airplane as a whole so that we can all visualize the problems of performance and assembly.

While we were unable, in the general rush, to prepare slides or elaborate exhibits for this talk, we have a few plastic parts here that I will be glad to show you. They are representative of the various types of parts that we want.

We now come to the important problem of how the S.P.I. and related groups can be of most direct help to the Government in the alternate materials program. We will not go over all the points enumerated in our discussions with your technical committee in New York, but there are a few points which we wish to emphasize.

In the first place, our fundamental requirements for immediate use are as follows:

1. Knowledge of the engineering properties, classification and method of ordering all the available materials.

2. Knowledge of the comparative cost and performance of all available molding and forming processes.

By engineering properties, we of course mean the properties related to aircraft uses. Our part is to tell you what properties must be known; your part is to collect or determine and to list those properties. Your committees are already planning this program. It must be completed in working form in the shortest possible time—that is, the basic classification and principal properties must be available to us.

Knowledge of the various molding and forming processes is our big bottleneck and arrangements for eliminating this lack of coordination must be decided upon immediately. We wish to make the suggestion, directed especially at laminators and manufacturers of resins, that the only way to come to a quick decision and start in on smooth production of built-up molded parts is for those manufacturers who possess resin materials and molding processes in any way suitable for the manufacture of built-up molded parts to gather around a table to pool their ideas. In this way the various sources which separately have incomplete information will combine to supply the complete picture. The Government and the industry technical committees would of course be represented. From this discussion we should decide definitely upon the best reinforcing materials, the best resins and the best molding processes. We should then start out to use these selected materials and processes to the exclusion of others for building the experimental parts that the Government wants.

We keenly realize the difficulties of working out such a pooling of knowledge in peacetime. By contrast we do not doubt that a suitable agreement can be reached in quick order at the present time. Arrangements for conferences directed toward this end will be one of the first duties of the new committee.

I shall close by summarizing (in outline form) the steps by which it is proposed that this program will be carried out:

1. The Government-industry committee will be formed and will receive official notice to proceed. The committee will meet to define the duties of the various members, Government bureaus and laboratories and industry subcommittees. Facilities for testing and experimental work will be discussed and decisions reached.

2. An exhibition of airplanes and aircraft parts will be arranged covering insofar as possible the entire field of aircraft structure and parts, control systems, equipment, accessories, power plant, fuel and oil system, etc. Later a similar exhibition involving auxiliary apparatus used in connection with aircraft will be arranged. A schedule of parts will be made up and action taken as to the status of the part—that is, suitable for immediate production in plastics, or suitable for manufacture of a dozen parts for laboratory and service test, or suitable for study and eventual action by a sub-committee on developments. The committee will then make the necessary arrangements with the Army and Navy and the aircraft industry for procurement of the parts including the engineering work necessary. One of the most important functions of the committee will be to prevent uncoordinated attacks on alternate material problems by several companies.

3. In the meantime the committee will be collecting all available engineering information on plastics from the Government and industry and will be deciding upon form of publication and classification—that is, in accordance with the Government rules governing restricted confidential and secret information.

There are numerous details concerning this program that of course we cannot mention or discuss at an open meeting of this type. You will understand, therefore, the reason for our generalizations.

Incidentally, the sub-committee on developments that we spoke of a moment ago will concern itself with some problems which we have in plastic applications for which we know of no solution using materials and processes known to us. It will also concern itself with the faults from an aircraft standpoint of certain plastic materials, and with the idea of accelerating research and development toward elimination of those faults.

In conclusion, we wish to state that this plan for action is not fixed but is designed to be flexible for the achievement of maximum results in the shortest possible time. We are confronted by an engineering and production problem. The solution of this problem requires leadership, resourcefulness and skill, but above all imagination and the cooperative spirit.

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Dr. Gordon M. Kline then discussed the "Why and How of Federal Specifications for Plastics." Compared to the adventurous thrill of discovering and evaluating new plastics, Dr. Kline said, the writing of specifications is as dry as a desert, and in fact like a trip through the desert through which there is a safe way if the traveler keeps to the route which is dotted with points of shelter, and avoids a devious route which might lead to trouble and confusion. "A specification for a material or article has much the same function as a plan of action for a military operation," Dr. Kline stated, "and the detail require-

ments replace the generalities of the preliminary survey of the problem and provide limits to ensure both that the job can be done with available material and that the material supplied will do the job. The methods of test serve to define each individual requirement and to assure that the results will be reproducible regardless of whom is called upon to do the job. A properly prepared specification represents a coordination of effort between manufacturer and consumer to the end that the nail which *is* supplied shall not be the cause of losing a battle." Dr. Kline went on to explain the need for adequate specifications, explained why Federal specifications are prepared and why separate Government agency specifications were used for small quantity purchases, and outlined the procedure followed in preparing Federal specifications. The present status of specifications on plastics, existing and pending was mentioned. Dr. Kline also explained the organization of the technical committees of the Federal Specifications Executive Committee, of which he is chairman and Lt. E. T. McBride, Army Ordnance Dept., vice-chairman. Membership of this committee is composed of representatives of numerous Government departments and establishments who are versed in the particular groups of commodities considered. (A complete report of Dr. Kline's speech will appear in an early issue of MODERN PLASTICS.)

DR. GORDON M. KLINE

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Third speaker on the morning program was Senator Harry S. Truman, who urged the plastics industry to translate the prophecy that the post-war period will be an "Age of Plastics" into the reality of tomorrow. He commented on the noteworthy contributions of the plastics industry to American technology and in countless war processes and urged members of the industry not to relax their efforts. Senator Truman reviewed the work of the National Defense Commission in checking the activities of Government defense agencies, and the progress of our war effort. He outlined the effect of the expansion of the armed services, Air Force and increasing production of war materials on supplies of raw materials for both military and civilian needs, and for housing projects, discussed the synthetic rubber situation, and urged American individuals and companies to sacrifice "business and profits as usual" and do their share for victory.

SENATOR HARRY S. TRUMAN

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Following the open session, the convention divided into the following sectional meetings:

Machinery, over which E. A. Stillman, Watson-Stillman Co., presided;

Materials, at which Clinton A. Blount, Bakelite Corp., discussed "Material Supply for War Purposes," and Whiting N. Shepard, Plaskon Co., Inc., spoke about "Plastics Advertising during the War";

Technical Committee: A closed meeting for members of that committee only was held under the direction of Frank W. Warner, General Electric Co., Plastics Dept., who later outlined the activities of his committee at the Tuesday business session.

Molders' Committee: The large molders' section meeting with G. A. Johns, American Insulator Corp., as chairman, had a very interesting session. Referring to the molders as "the heart of the industry," Mr. Johns said that the greatest progress demanded cooperation and that these meetings afforded the molders an opportunity to discuss mutual problems. Proof of this statement was evident in the report of J. B. Neal, Norton Laboratories, Inc., chairman of the Labor sub-committee of this section. Mr. Neal reviewed the activities of his committee in a compilation and analysis of wage rate data in different localities and other pertinent labor information. After a discussion period, plans were formulated for the Society to continue this type of survey.

Roy Cunningham, Bryant Electric Co., chairman of the subcommittee on Standardization of Inserts, reported on the committee's findings and recommended that this program be discontinued until after the war, as considerable designs changes at that time will create many problems to be solved in standardizing all types of inserts.

The Nominating Committee, represented by George Scribner, Boonton Molding Co., chairman, then nominated Norman L. Stafford, Diemolding Corp., as chairman of the Molders' Section for the coming year. Mr. Stafford was elected unanimously.

Highlight of the Molders' Section meeting was the report of Alan W. Fritzsche, chairman of the Molders' Group, an industry-wide committee set up separately last fall. Mr. Fritzsche reviewed the multiple activities of this group which included sending out a questionnaire to obtain vital data, the compilation of which was presented to OPM, who were preparing improved methods of allocating phenol, formaldehyde and methanol. He reported in detail the work of the committee cooperating with Government agencies and sponsoring several important meetings of industry and Government representatives to discuss urgent plastics problems. Because of the splendid efforts of this committee contributing to the welfare and promotion of the war activity of the industry as a whole, it was decided to continue the group and obtain additional funds to defray expanding future operations. In addition to the present members—Henry J. Kasch, Kurz-Kasch, Inc.; Charles Dewey, Shaw Insulator Co.; James B. Neal, Norton Laboratories, Inc.; Elmer C. Maywald, Chicago Molded Products Corp.; George I. Anderson, Auburn Button Works, and Hans Wanders, Northern Industrial Chemical Co.—the following injection molders and extruders were confirmed as members of the board: Perry Goodspeed, Irvington Varnish & Insulator Corp., W. H. Fryling, Erie Resistor Corp., and J. Foster, Foster Grant Co.

Further plans for extending cooperation with Government agencies in order to expand uses of plastics in the war program, survey idle equipment in the industry, and help conversion of other strategic materials to plastics were discussed. It was suggested that the PLASTICS CATALOG be made available to all important Government services, procurement agencies, laboratories and technical bureaus who might want information about plastics; and L. T. Barnette, editor of MODERN PLASTICS magazine, reported that the publishers had already taken steps to send such complimentary copies to department heads and given instructions to make the PLASTICS CATALOG and current issues of the magazine available wherever needed. The meeting was then adjourned.

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Principal speaker at the formal banquet Monday evening, was Sir Henry Self, K.C.M.G., K.B.E., C.B., Director General of the British Air Commission and civil member of the Combined Staffs, whose sincere, informative and inspiring talk was enthusiastically acclaimed by a very attentive audience. Sir Henry's discussion of the part plastics are playing in the British war program and our ally's interest in the American plastics program was particularly instructive, as is evident from the transcript below:

I count it a very great privilege to be allowed to address you tonight at the annual gathering of the Society of the Plastics Industry. I confess an exceptional diffidence in approaching such a responsibility after a study of the comprehensive program

of your meetings which reveals clearly the wide scope of your activities and the very distinguished gentlemen who are contributing to your discussions. I fear that I shall fail to do justice to the great importance attaching to your discussions in their effect on the war effort. I know well how great a part the plastics industry is playing in that effort, and therefore ask your indulgence in my attempt to give to you tonight some indication of the British industrial achievement and its significance for the common cause. I feel sure you will overwhelmingly agree that pooling of thought, experience and practice is essential between the United Nations if the joint war effort is to be brought to its full fruition.

In peace, competitive effort is the great stimulant to efficient production. Paradoxically, this competition in war time sacrifices itself to the common weal so that all may share in the knowledge of the few. The stimulation is itself provided by the joint anxiety that the cause of free and private enterprise may once again come into its own in a happier world and under conditions which would be forever lost if the totalitarian powers should secure the worldwide sway for which they have so foolishly dreamed and gambled.

I should perhaps give you some short statement of the only qualifications that I may have for appearing before you tonight. They consist in brief in some thirty-five years' public service on behalf of the British Government during which my service has stretched over some ten Government Departments during which I have been associated with the supply work of the British War Office and the British Air Ministry, respectivel During these periods I have perhaps been in a fortunate posit.n to study the progress of industrial organization and practice in relation to the supply of munitions and aircraft for the use of the British armed forces. It is from the basis of that experience that I presume to speak to you tonight. To one who graduated from the Royal Ordnance Factories at Woolwich—these being the original British Government munition factories—the contrast stands out in most vivid form between the scale and methods of production in the early years of this century and those now employed.

We were, for example, often reminded during the years leading up to the present war of the vast scale of aircraft production achieved in 1918. Again and again we in England were challenged as to why we could not achieve like results. Our halting answer was, "But look at the change in types, the difficulties of metal construction, the enormous development in engine power and comprehensive refinements in technical equipment and armament." Yet this was, after all, but an excuse! The results achieved in 1918 were in themselves a miracle as compared with the pre-1914 years. We have seen a like miracle in the making since the time of Munich when those criticisms were most prevalent. Today there is springing into full realization a supply program in the United States and in Great Britain which far surpasses that of 1918 and represents an even greater relative advance over what was deemed possible in the recent times of peace as compared with the transformation achieved in the First World War. I would venture from personal experience to try and bring out a few of the highlights behind that story; and to do so firstly from close contact with, and indeed some responsibility for, the British aircraft effort over the critical years 1935–1940 and, secondly, from observation during the last two years of the amazing progress achieved in the development of American aircraft and other war industries.

In making this approach, I feel sure you will agree with me in the necessary emphasis on the fact that maximum results can only be achieved by close pooling and joint organization of the production of the United Nations. For example, production in England may be better concentrated on certain types of weapons with corresponding concentration on others in the U. S., so that the overall production is greatly benefited. The need for this is further illustrated from the standpoint of keeping shipping requirements within the closest practicable limits and so, for example, arranging for production of types in the geographical location best related to the theater of war in which they will be used.

Furthermore this close coordination and pooling will enable the fullest interchange of American and British experience and so insure that both sides are achjeving the best practicable results within the limits of present knowledge. I would like to illustrate this point by reference to British experience on the use of plastics in aircraft. In England, the urge to use plastics on aircraft came from the shortage of light alloy and attention therefore was first directed to parts where light alloy could be saved. The difficulty immediately encountered was that the aircraft industry generally knew nothing of plastics and it was inevitable that there should be a certain measure of prejudice against them. The plastics industry was equally inexperienced in aircraft technique but showed a most progressive spirit in finding new openings for its products.

SIR HENRY SELF

This reciprocal inexperience was overcome by the formation, sponsored by the British Ministry of Aircraft Production, of a team of two men, a prominent plastics engineer and an experienced aircraft engineer. This team exchanged their knowledge and paid visits to the firms concerned. It was found that repeated visits over a period of some nine months were necessary to get effective collaboration. This educational process is most important; and if the best use is to be made of plastics, the aircraft firms themselves must learn how to design for manufacture in plastics and be as familiar with the wide range of plastic materials available as they now are with steel and light alloys.

As a result of these activities, a Plastics Technical Committee was formed to maintain contact between the two industries. Designs for a number of standard parts in plastics for use on any type of aircraft have already been prepared and more are on the way. There is thus a steady movement toward the use of plastics in subsidiary parts where high specific strength is not needed. A well-known large item is the pilot's seat for the Spitfire. This weighs the same as the metal seat it replaces and in quantity production is considerably cheaper.

Molded plywoods of the Vidal and Duramold types were first not encouraged in Great Britain because the available supplies of plywood necessitated careful rationing in the same way as for light alloys. This position, however, is now easier and an increasing use of this class of plastics is to be expected.

We follow with great interest the development of this material in the U. S. and it is being intensively studied by the National Research Council in Canada.

It is perhaps not fully recognized what tremendous progress has been achieved in America during the past two years. We in England first responded to the need for re-arming against the menace which threatened Europe as early as 1935. We were then confronted with war industries which were not capable of undertaking a program of any magnitude without considerable expansion and development. The resulting period up to the time of Munich in September 1938 was one of bitter anxiety and activity. Difficulties were experienced which were quite unexpected; inevitably mistakes were made in the learning of the necessary experience underlying the changed conditions which resulted from the vast development of human knowledge and technique since 1918. Throughout this period output was continuously below expectations, and it was not until after Munich that the tide turned and we saw a rising crescendo of production which has since enabled Britain to save herself and, we feel sure, by her example save the world.

It was a particularly trying experience in the development of aircraft. The transition from wood to metal construction had introduced a completely new technique. The rapid development of engine power; the introduction of new fighting tactics involving high speed and altitude for fighters and long range and great bomb load combined with adequate defence for bombers; the complexity of aircraft instruments and armament. All these factors contributed to a host of problems which only time and labor could solve.

Let us recall the history of the Spitfire fighter, which today is still in its developed modern form the outstanding fighter in the battle of Europe. That aircraft type evolved out of certain racing models developed in the early thirties and made possible by the evolution of special Rolls-Royce engine types which were designed in the first place purely from the performance possibilities. The airframe, engine and equipment were all developed in relation to maximum performance and without equal regard to the problems of quantity production. Out of this urge toward great speed at high altitude there emerged the Spitfire as a type, but the problem of producing it in large numbers still had to be considered. It was only after more than two years of very anxious and trying work that these difficulties were overcome, so that by 1940 large numbers of this magnificent fighter flowed forth into the Royal Air Force and enabled them to win the battle of Britain.

My point in recalling this history is to draw attention to the period of time that was necessary to translate possibilities into actualities against a background of peacetime activities in England. The effective period was from 1935–40. It was in 1940 that the American defense program was initiated, and as one who has witnessed the amazing evolution of that effort, I venture high tribute to the achievement within a period of two years of so great a transformation from peace to full war production. That achievement was in part made possible by applying the lessons of British experience over the previous five years. The production difficulties were foreseen; the lessons of actual war combat experience were correctly understood and translated into efficient designs.

The significance of this application of British experience to the development of the American program is a speaking testimony to the value of close coordination of the war efforts of the two countries. But the achievement could not have been realized anywhere but in America. The great genius of this country, its unique production capacity, its supreme ability to organize mass production and improvise technique for making complicated structures in large quantities—these, combined with the inexorable determination of the American people, have yielded war industries on a scale which will constitute the determining factor in this great world struggle.

To those of us who have witnessed this amazing achievement, the future holds great promise. We have passed through great times of anguish and turmoil; we are still enduring a series of trials and difficulties; we may yet have to pass through a period when the offensive that will ultimately come is delayed while its power is developed. But the worst is behind and it seems to be a matter of simple, cold, hard calculation to measure the ultimate consequences attending on the adaptation of American industry to an all-out effort on war production. With 130 million people in America, supported by 45 million in England as the backbone of the supply effort of the cause of the United Nations, there can be only one ultimate outcome. Right has hitherto been bereft of the support of a strong right arm. Even now its power is not equal to its task; but that power is growing and growing fast. In the task that lies ahead, supported by the products of American industry and enterprise, the future holds great promise and is one toward which we can go forward with confident hope, strong in our united strength and firm in our aspirations.

To you gathered here tonight has been assigned a special part in that great effort. You are sponsoring a contribution by the plastics industry which has very real significance in the overall picture. We in England have long appreciated the part which plastics must play. Indeed, the demand for substitution of plastics for supplies or parts of complete equipment wherever possible has produced so great a demand that a comprehensive system has necessarily been evolved to insure that the basic materials required for the production of plastics are properly controlled.

Plastics Control arranges for the supply of many of the raw materials of the industry, including such items as formaldehyde, phenol, cresol, steel molds, etc., and also regulates the disposal of the finished products. A special substitutes Committee exists coordinating the work of all the Government Supply Departments and one special field of their activities is in connection with plastics. As the list of materials in short supply has lengthened, and as the application of plastic products for an increasing range of purposes has become limited by the availability of the chemicals from which they are derived, a special Plastics Advisory Service has been established for guidance in the formulation of specifications. This service is specially concerned to insure that the various types and merits of plastics shall be employed for those purposes for which they are particularly suited.

In the region of plastics the objective of this British organization has been to meet the growing demands of the fighting services for components and constructional materials. Substitution by plastics has been directed in particular toward the saving of light alloys. To achieve this it has been necessary to restrict by license the use of phenol- and cresol-formaldehyde resins and molding materials to clearly defined essential needs. Of the thermosetting plastics, urea-formaldehyde remains in good supply to meet such essential governmental requirements as do not call for phenol or cresol and certain essential civilian and public needs.

The production of cellulose acetate sheeting and molding powders is mainly governed by the supply position of plasticizer and almost all the present production is directed to Service needs, i.e., aircraft glazing and anti-gas eye-shields. A more recent development has been the use of black acetate sheeting in aircraft construction for non-stressed parts. Very considerable savings in dyes and pigments have been achieved by limitation of the color range in plastics and by limitation of the quantities of such color media in the small range permitted.

With your permission, I would conclude with a brief appreciation of the scope of the British effort in the common cause. I feel sure that many of you have read the speech delivered by Lord Halifax on March 16th when he recounted the outstanding features of the British effort in England throughout all quarters of the globe. Therein he drew attention to the magnitude of the effort in relation to the size of the population and the country itself. I will not attempt to go over that ground again tonight, but I would submit to you that such an effort has never been seen before in the history of humanity and will only be surpassed by the achievement now in the making by this great continent. To you here with such a vast population and so great resources, supported and guided by a unique genius both in the fighting services and in the world of supply, the significance of the British effort will be readily understood.

Lest you should think that I am over-stressing the significance of supply in this conviction of the ultimate outcome of the present struggle, may I recall the remark of one of the most successful Generals of the last war, who himself had been one of England's best Quartermaster Generals. Lord Plumer said that "Strategy is subservient to Supply." To you who are contributing so much to that supply effort no emphasis on the significance of this statement will be necessary. The ultimate outcome of the present struggle will depend on the successful achievement of the supply programs on which the United Nations are embarked.

My object tonight has been to present to you the picture of the united supply effort supporting the cause which we know to be that of the right. We are joined together in that cause and Britain, you may feel sure, will never be lagging in support of that greater effort now emerging in its fullness within the United States of America—the home of humanity and freedom. The struggle has been long and may be longer still, but to us who have put our hands to the plough, the vision rests on the horizon when hope will be turned to realization and the struggle for life and freedom will be victoriously ended. We, one and all, have a trust bestowed upon us. A great Christian Apostle once said, "If I do this of mine own will I have a reward; but if not of mine own will I have a stewardship entrusted to me." That stewardship is entrusted to us on behalf of the democratic cause. We will not be found wanting.

At the Tuesday morning session, the first speaker on the program was Hamilton W. Wright, of the Industrial Salvage Section (one of the four branches of the Bureau of Industrial Conservation), substituting for George T. Weymouth, Chief of that division, who was unable to attend the meeting. Mr. Wright discussed salvaging materials of all kinds throughout industrial plants, the objectives of his division, and asked that the plastic and allied industries, too, take an active interest in this vitally important part of the effort. He informed the group that Donald Perlman of the Plastics and Chemicals section of the Industrial Salvage Section would shortly get in touch with individual members of the industry to work out the salvage program best suited to the industry, and expedite collection of both plastics and metal scrap.

"Much can be done," Mr. Wright said, "in finding some way for regrinding and re-using methyl methacrylate, ethyl cellulose, acetate, butyrate, vinyl and polystyrene scrap. I have been informed that in the areas around some plastic plants there are large dumps of plastic scrap for which no salvaging methods have been attempted. I feel certain that all it requires is a description of our need for all vital scrap materials and your industry, like all others, will respond to our plea for cooperation so that this condition, allowing dormant scrap to remain dormant, will no longer exist."

Mr. Wright then reviewed the facts and figures covering the need for raw materials and scrap by the industries engaged in producing war supplies, and explained why such tremendous tonnages were required in order to produce new materials. He described the method of operation of the Industrial section which operates in four ways: (1) Through industrial centers; (2) through trade associations; (3) through governmental agencies; (4) through industries vertically. The last approach will probably be used in the plastics industry in order to circularize it from top to bottom. Mr. Wright suggested the following as a practical pattern, although he stressed the importance of a flexible plan to meet all conditions: Work through established channels of collection. Advise WPB that scrap has been moved to certain dealers but do not attempt to allocate it yourselves. Decide right away what should be re-used, reclaimed or scrapped. Segregate your scrap piles—keep them free from dirt and contamination. Prevent waste by better purchasing, better engineering, better production, packing and shipping. Find markets for equipment and surplus stocks which some other plant can use. Keep on hand a list of scrap dealers and yards through which various types of scrap can be speedily turned back into production. Keep the enthusiasm among the employees high by devising incentives and awards for conservation work. Establish and keep frequent contact with the Industrial Salvage Section. And, finally, "Help America stay in this scrap by getting in your scrap."

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One of the most important addresses of the convention was delivered by Charles A. Higgins, president of the Hercules Powder Co., who discussed the plastic materials supply situation under the title, "Powder and Plastics." Mr. Higgins' speech follows:

Outside my office at Wilmington hangs a poster which, in startling red letters inquires, "What have you done today to help win the war?" I like that poster because it constantly spurs us on to the immense task before us. And it should be a reminder to us at this meeting that whatever we do or say should be capable of being translated directly into the war effort. I am not here today in the rôle of a plastics expert, but I am proud that my company is closely identified with the plastics industry as one of the major suppliers of chemical materials, particularly cellulose derivatives and, more recently, a factor in the development of resinous materials and extenders.

What is this plastics industry? What has it done? What are its major obstacles? Where is it going? These are pertinent questions to review today. For, from the answers to these questions we can obtain clues which in turn will enable us to understand more thoroughly our part in the war, be more useful in the war, and eventually will help us to take our rightful place in America's industrial scheme.

CHARLES A. HIGGINS

What is the plastics industry? You technical men who have helped to make this industry advance faster than probably any other American industrial group in the past decade (extraordinary war industries excepted) know that the plastics industry is more than separate groups of molders, laminators, converters, machinery manufacturers and raw material suppliers. This phenomenal progress required a combination of the genius of the molders to achieve speedy mass production, the ingenuity of machinery makers, and the chemists' skill in bringing forth new and plentiful plastic materials to create a substantial business whose products have been moving into almost every part of our national life at a rapidly accelerating rate.

What has the plastic industry done? First of all, it has grown up. It has grown beyond the gadget stage where industrial analysts and convention speakers took it upon themselves to list the myriad products made of plastics, running from push buttons to bracelets, or from paper clips to costume jewelry. Like their products, the industry now is made of sterner stuff and is capable of bigger things. Now plastic parts are going into tanks, planes and battleships.

But just how far have we come? According to the best data obtainable, the production of plastic materials from 1929 to 1941 increased something like 650 percent. During this same period general manufacturing industry throughout the country increased by only 42 percent. In the single year from 1940 to 1941, our plastics increase was roughly 100 percent, caused largely by the giant strides made by the coal-tar resin plastics. This branch of the industry apparently more than doubled its output; the cellulose plastics increased over 50 percent in the same twelve months; and many of the other plastics showed as large, or larger, percentage increases. Then came our entry into the war, and in 1942 we are likely to see an actual decline in plastics output. The best available estimates forecast a decrease for the current year while industrial production in general will probably increase about 15 percent or more.

Now, at a time when every ounce of production is precious, we should consider this decline in plastics activity. There has been an important break in our forward march. This year we are sliding down instead of climbing up. Now we have idle capacity when we should be running twenty-four hours a day making the munitions of war.

While this is a discouraging aspect, the situation is not hopeless, since plastics are indicated for greater use in our growing arms production. Methyl methacrylate and cellulose acetate are providing the observation points for airplanes. Ethyl cellulose is insulating the ignition systems of internal combustion engines. The vinyl resins are taking the place of rubber in impregnated cloth. The phenolic, the urea and the styrene resins are making a multitude of products for the Army and the Navy. Soon civilians as well as soldiers will be familiar with the acetate eye pieces in gas masks. These applications are only a start. It is up to us to convert the plastics industry to full-scale war production.

What are the major obstacles to the growth of the plastics industry? I am telling you nothing new when I say that the big problem confronting the plastics group today, as it faces all other industries, is the transition to a war economy. We are faced with increasing demands at a time when our ability to meet them is lessened. The lack of raw materials plagues us; priorities are a thorn in our side. This dilemma has brought little but broken promises to old customers, a loss of profits and goodwill, and even the irony of unused capacity.

One of the serious difficulties of the plastics industry today is

a lack of raw materials. Why? Because these same chemical materials, or derivatives of them, are being diverted to the manufacture of military explosives. Consider smokeless powder, for example. After all, it is essentially a plastic based on cellulose nitrate. And it is a very good plastic. Because its production is so tremendous (many times that of all other plastics combined), there has been a necessary diversion of cellulose from plastics to smokeless powder. This is just one instance. Listen to some other important diversions: The supply of phthalates used for plasticizers has been sharply limited by the diversion of tremendous quantities of phthalates to the manufacture of powder. Many of the plants making methanol, required for formaldehyde for the phenolics, are now making ammonia, vitally necessary for almost every type of explosive. And this situation has been somewhat intensified because formaldehyde itself is used in a modern high explosive. Alcohol and acetone, used for the manufacture of nitrate and acetate plastics, are consumed in large quantities in the manufacture of powder. Finally, nitric and sulfuric acids, needed for nitrocellulose plastics, have been diverted to the manufacture of both powder and TNT.

You can see that the vital materials of plastics are actually the vital materials of war. When you hear that Allied planes bombed Tokyo or the German industries of the Ruhr Valley, you may have the satisfaction of knowing that diverted plastic chemicals helped to do the job. News received from the War Department today will probably give you a better picture of what has been accomplished with the chemicals that have been taken from you. I am pleased to be able to tell you that the forward thinking and planning of the Ordnance Department of the United States Army was, to a large extent, responsible for the tremendous impetus to explosives production in the United States. Partly because of this foresight, the rate of production of smokeless powder on March 31, 1942, less than four months after we entered the war, had already surpassed the maximum output of powder reached in the United States during the first World War. When you get facts like this, perhaps you wonder that the dislocation in the plastics industry has not been even greater.

Where is the plastics industry going? This is the heart of any dissertation concerning plastics. All of us want to do our part in the war effort—because we think and know that plastics can do a big job. Well, then, here we are with both assets and liabilities in this transition to a war economy for our industry. On the one hand we have the increasing and demonstrated usefulness of plastics—their ease of fabrication, moldability, dielectric strength and general structural qualities. On the other hand is the comparative newness of the industry—a lusty boy among industrial giants—its lack of integration or business organization, particularly in its approach to the Government production agencies, and finally there is severe competition for raw materials.

At this moment, when American industry is straining to increase its industrial capacity, there are idle molding machines. This, to my mind, in view of the proved usefulness of plastics and the needs of our war program, is nothing short of tragic. Perhaps the most pressing need of the plastics industry today is an increase in the supply of chemical materials. Part of the millions of dollars going into the war program might well be allocated to an increase in the productive capacity of chemical materials that could be allotted to the plastics industry. Every day you read in the papers something about the sensational expansion of such materials as synthetic rubber, aluminum, magnesium, zinc and similar metals, largely through Government-subsidized plants. These materials are generally considered to be competitive with plastics. Evidently these industries have done a better job than we have in preparing for conversion to a war economy.

For example, consider synthetic rubber. Certainly we need synthetic rubber, yet for many uses plastics could do as well or perhaps even better. Some of the rubber and synthetic rubber products which might be made of plastics are raincoats, many of the essential hospital appliances, wire insulation, footwear, floor coverings, innumerable parts of airplanes and of the indomitable jeep, and perhaps even tire casings. I think this point will bear investigation in our attempt to meet the competitive situation in rubber.

But to get back to our main topic about the shortage of chemical materials: If the Government should make available a supply of these strategic materials, the very lifeblood of the war chemicals, you can be very sure it will demand that they be applied to war uses. Producers who say, "I will hang on to my peacetime business as long as I can," must change their attitude. They must not merely give up peacetime business, they must not merely take the orders the Government hands them, but they must actively go out and seek war contracts. They must not wait for orders to fall in their laps, but must sell their plastics to the Government just as American business has always sold its products to a tough customer. They must tell the WPB what they can do, and volunteer for war contracts whether or not it means a cut in the net income. To look at it realistically, in a very few months war business and essential civilian needs will be the only kinds of business which will remain Either we go into war business, or very likely we go out of business altogether. There is no alternative.

My last question, which I purposely omitted from my opening list of questions is, *"What are we going to do about it?"* The first thing we've got to do is organize ourselves for this particular job of war conversion and planning. Much work has been done with and for the Government, both by individual companies and committees of the S.P.I.—for example, the Molders' Committee. Gone are the days when we can afford to make up competing samples for a particular application. Time is too short; material is too precious; the need is too great. Now, we've got to organize and demonstrate the present and future worth of plastic materials. On the merits of our products, we can convince the Government that plastics capacity should be increased. Unless we do this, we are going to let our wealth of technical progress go to waste because we did not have the courage to build plants until after they were proved to be the missing part in the program. Remember the synthetic rubber industry had the courage and facts to go ahead. In fact, a number of other industries have faced this crisis with courage and resourcefulness. We can do the same.

It would be easy if we could sit back and leave it up to the Government to do the necessary planning, evaluating and deciding. But that won't do. An organization such as the Society of the Plastics Industry which knits together the raw material suppliers, the machinery producers, the converters, the laminators and, finally, all of the molders into an effective group can perform a great service both to the nation and to the industry. I submit that the first steps must be taken by you men here; it is up to the plastics industry to do something itself.

Specifically, I propose a Plastics Planning Board. Its first work should be:

1. To survey the possible and probable future uses of each plastic for war material.
2. To determine the amounts of raw materials, converting equipment and molding capacity required for such uses.
3. To provide the WPB with concrete proposals based upon their surveys.

The Planning Board will not solve our problems today or tomorrow. We must remember that it takes time and straight thinking to organize such a program. To have the solvents, dyes, plasticizers, fillers, tools, presses, molds and finishing equipment ready when needed, we must start planning now for the plants which will deliver the goods six months or a year hence.

Such a master Planning Board, once functioning, would help in the other half of the problem, that of speeding up the adoption of plastics in those war uses for which they are pre-eminently fitted. This board, an overall head for the industry, should enable the Government to take full advantage of the productive facilities of the plastics industry. It should fully and promptly provide the opportunity for prospective suppliers to learn what actual parts and assemblies of material are required. And finally, by working with the Government, Government contractors and the Technical Committee of the Society of the

Plastics Industry, it should be able to stimulate more rapid approval of plastics by the Government Department concerned, and thus speed up the conversion of the industry to full-scale war production.

Organization, planning, technical detail, plant construction—these are things which have never baffled Americans in the past; they are our strong points! The planning and execution of such a program must come from those who represent the plant capacity, the materials and the technical skill required for the mobilization of plastics for war.

In all sincerity, I believe I speak the truth when I say that the crossroads we have reached is this—either the American plastics industry will go forward to perform a remarkable part of the war production program, or else it will become one of the conspicuous failures in the war effort. When I see before me such an array of skill, talent and executive ability, the very elements we need, I know we shall not fail, and I am inclined to say, "What are we waiting for?"

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William Haynes, chemical economist and author of "This Chemical Age," approached the plastic situation of today and tomorrow from a unique point of view in his talk on "The Silver Lining to Priorities," which follows:

I hope that you have not been misled by the title of my talk, The Silver Lining to Priorities, into thinking that you are to hear what a great and glorious opportunity is being created by priorities on metals, coatings and what-not for plastics to substitute for these ancient and honorable materials. I am not going to prophesy that you are coming out of this war the veritable lords of modern industry in America, the masters of The Plastic Age.

You know all about this. You know that some of it is quite true and that a lot of it is the moonbeam popular science that fills up the magazine sections of the Sunday papers. Every man in this room, I will wager, believes sincerely that plastics are THE materials of the future. I agree with you, and I will go further, for I believe that synthetic materials—rubbers, fibers, drugs, as well as your plastics—are going to have a great deal more effect on the lives of our great-grandchildren than Hitler or Mussolini, than Chamberlain or Roosevelt.

If you doubt that new materials can compel the course of history as greatly as any man, think of bronze. We don't know who invented that first synthetic metal. We don't know the people who first used it. We don't know the army that was first equipped with bronze swords and spears. But we do know that bronze weapons conquered the Stone Age; that bronze tools brought man from savagery to civilization.

WILLIAM HAYNES

Who remembers the name of the general who fought the first *blitzkrieg* with gunpowder? But who can forget that gunpowder blasted the deeply entrenched feudal system out of history, over-throwing the powerful alliance of Church and State, toppling the knight in armour from his high place, freeing the serfs from their land-locked slavery?

Without cheap steel, there was no steam engine. It was the steam engine that wrought the Industrial Revolution upon which our whole present social, political, economic existence is based. Indeed, yes, materials have written history, and we are agreed that plastics are THE materials of the future. But of what future? What kind of future?

It becomes increasingly difficult to foresee what the future has in store for us, but everybody agrees at least that it will be different, that there will be changes. Change is not something new, and judging from the past, certain changes that will concern the plastics industry can certainly be foreseen.

Only 150 years ago Watt and Newcomen harnessed power and Hargraves and Arkwright put it to work making cloth. The engineers got busy, and kept our grandfathers busy keeping abreast of the new and improved machines they turned out. Yesterday the manufacturer who failed was the one who allowed his plant to become obsolete.

Then about fifty years ago the Count de Chardonnet made the first synthetic fiber, rayon; and John Hyatt made the first synthetic plastic, Celluloid. After that, especially since the First World War, the chemists got busy with the result that today the manufacturer who fails is he who lets his product become obsolete.

You gentlemen are past masters at the modern art of keeping products up to date, even a little bit ahead of day after tomorrow. You have done a splendid job in awakening other industries to a realization of styling and the use of color; to an appreciation that a product can get out of date. Do not therefore become complacent about your own products. Remember that materials, as well as styles, become obsolete.

That is why research is so enormously important to you today and will be more important tomorrow. The improvements in grandfather's business were brought to him by the machine builder and the toolmaker. Yours are thrust upon you by your competitors. He could judge for himself the value of a new machine, could figure for himself its cost balanced against its performance in profits. You have an infinitely more complex problem, for you must formulate and compare new materials. He could get along very well without research. You cannot afford not to carry on ceaseless research. There is a vast difference in the two points of view

Grandfather was able pretty much to get along in business without the Government. It touched his daily affairs but lightly; to you it looms exceedingly large. One of the great changes of this generation has been this growing importance of Government in economic circles, a change that has been summed up in a vivid phrase by a man many of you must have known, Francis P. Garvan. He was a fighting, loving, laughing Irishman and a devout Roman Catholic. You must know this to get the full force of this story. For many years I lunched with him frequently in his offices in New York, and on one of these occasions, he turned to me abruptly, as was his manner, and said:

"Did you ever stop to think that since the earliest dawn of civilization, since the days of the chief with his big club, and the witch doctor with his charms, all through the great empires of antiquity, through the Dark Ages, to our modern democratic, scientific era, the cream has always been skimmed off the labors of all mankind by two great powers: the Church and the State, tithes and taxes. We happened to have been living in one of those very brief periods in human history when these two great predatory powers had jockeyed themselves into a stalemate and when the ordinary man had the opportunity to taste a little cream. But now, when as I look over the whole world, it seems to me that Government is coming back into power."

Another change sure to come is the violent transition from war to peace activities. With it, unless the lessons of the past are all wrong, we will have first a boom and then a depression. If the industries of the land do not meet the challenge of that depression and provide employment, we may be sure that Government will step in and try to do so. So far as private enterprise, the American way of doing business, is concerned, we may have won the war but we shall lose the peace and that is why industrial leaders in many fields are today laying plans for what they will do when they stop selling war supplies to the Government. In the forefront of that effort they put the new industries, which means amont others, this plastics industry of yours.

Put not your trust in politicians. They have always been promising their people the more abundant life: the Kaiser, "a place in the sun"; Henry of Navarre, "a chicken in every Frenchman's pot each Sunday"; Caesar, "no Roman citizen shall starve." But those promises have been made good, not by the voluble politicians, but by a hard-working army of explorers and inventors, chemists and engineers, merchants and industrialists. Again we stand on the brink of a great revolution. It will be, not a political revolution, neither fascism, nor communism, nor even a New Deal; but a Chemical Revolution, in which man-

made materials—not substitutes or makeshifts, but new materials, better and cheaper and more adaptable to our use, will play the historic rôle of bronze and gunpowder and steel.

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Following the principal speakers, President Ronald Kinnear opened the business session. Lt. Comdr. H. D. Quinby, Jr., of the U. S. Navy Bureau of Ordnance, took the rostrum to invite the members to a special Washington meeting on Wednesday, May 6, to help the Government solve an important substitution problem involving fire control apparatus. The representative item of this type to be discussed was a binocular. (Further important developments arising from this meeting will be reported in MODERN PLASTICS at a later date.)

Mr. Kinnear and Mr. Cruse then delivered the President's and Secretary's reports, respectively, outlining the activities and financial and membership status of the Society to date, and thanked the Directors and members for their support and L. B. Gillie for his work as program chairman for the convention.

Frank W. Warner, Chairman of the Technical Committee, read the following report of his section's activities during the past year:

The S.P.I. Technical Committee has been charged with the evaluation of new developments in plastics, with the standardization of established commercial plastics materials and practices, with the constructive criticism of specifications for plastics, and with technically assisting governmental departments upon request.

FRANK W. WARNER

Technical Committee activities began with a joint meeting of the committee, of technical representatives of aircraft manufacturers, and of technical representatives of the Army Air Corps, the Bureau of Aeronautics, and the Naval Aircraft Factory in Dayton, Ohio, January 14, 1942. The speakers were Messrs. F. B. Fuller, Army Air Corps; W. R. Koch, Army Air Corps; H. Sang, Naval Aircraft Factory; G. DeBell, Glenn L. Martin Co.; S. K. Hodgson, Vought-Sikorsky Co.; W. D. Craig, Jr., Grumman Aircraft Co.; and Dr. G. M. Kline, Bureau of Standards.

This meeting emphasized the lack of understanding between the aircraft and plastics industries. Aircraft engineers deplored the lack of usable basic engineering data on plastics, and desired information on plastics engineering procedures and on methods of processing and fabricating plastics. They classified airplane parts as primary structural, secondary structural, or non-structural, and indicated that plastics could be used for the secondary structural and non-structural parts. They generally expected plastic parts to be used interchangeably with metal parts and to operate over a temperature range of minus 65 deg. F. to plus 160 deg. F.

The Technical Committee met in Cleveland, Ohio, January 27, 1942, to discuss the Dayton meeting. Here a memo was drafted discussing briefly thermoplastic and thermosetting plastics, existing material tests, and engineering data. Available thermosetting molded plastics were classified into four mechanical grades. This memo was distributed to the aircraft manufacturers.

The Technical Committee next met in New York City, March 10, 1942, to plan the long range committee program. It was decided to work closely with the Naval Aircraft Factory on their evaluation of plastics for aircraft use. Sub-committees were tentatively organized to facilitate this.

A meeting was then held in New York City on April 3, 1942, of the technical committee and the members of the sub-committees for organization and discussion of program. This was followed by a meeting with Lt. Comdr. Scoles and Mr. Sang of the Naval Aircraft Factory in New York City, April 4, 1942. Mr. Sang outlined the following comprehensive program on plastics:

1. Functions of the Naval Aircraft Factory:
   a. Develop existing and new materials where needed.
   b. Develop existing and new processes where needed.
   c. Conduct more extensive tests on parts.
   d. Contract for experimental plastic parts to replace metal on production planes to:
   (1) Use as many plastic and plywood parts as possible.
   (2) Accelerate the development of extremely promising materials and processes.
2. Factors limiting the application of plastics:
   a. Plastic materials are new and strange to aircraft designers.
   b. The processes of fabrication are new.
   c. No adequate compilation of properties exists, nor are there any standards.
   d. Poor contact exists between the aviation industry and the plastics people.
   e. There has been no strong consistent Government policy on alternate materials.
3. Requirements for expediting the program:
   a. Collection of engineering data held by industry and a capitulation of present research programs.
   b. More efficient procedure.
   c. Proper outlets for circulating engineering information on plastics.
   d. A system for handling confidential data between Government and industry.
4. To accomplish results, NAF and the Government must have:
   a. Complete data on past and present research.
   b. Data on engineering and production facilities.
   c. Technical assistance of the industry in the preparation of specifications, standards, and circulars.
   d. Cooperation and assistance of the industry in the development and the testing involved in the program.
5. Shortcomings to be eliminated:
   a. Duplication of effort by Government, aircraft laboratories and industry.
   b. Concern over secret or confidential processes.
   c. Lack of imaginative engineering talent in plastics and aircraft industries.
   d. Tight purse strings.
   e. Lack of complete circularization of engineering information.
6. Immediate Naval Aircraft Factory problems:
   a. Laminated, mainly thermosetting.
   b. Molded, 75 percent thermosetting, 25 percent thermoplastic.
   c. Resin-bonded plywood.
   d. Special forms of wood, such as compregnated wood.
   e. Adhesives for joints.
7. Suggestions for a Government-industry committee:
   Purpose:
   a. To get plastic and plywood parts in production as soon as possible.
   b. Expedite laboratory and service tests.
   c. Choose the developments to accelerate, such as:
   (1) Adhesives for joints.
   (2) Improved woods.
   (3) Inexpensive molding methods.
   d. Collect and correlate existing data.
   e. Fill in gaps by an active test program by N.A.F. and industry.
   f. Lend technical assistance in preparing specifications, standards and circulars.
   g. Act in advisory capacity on allocation of contracts.
   h. Pool information on new processes, materials and lines of development, or at least submit sufficient information to a central committee to evaluate such development and place it in the program.
   i. Act as coordinators to supervise and report progress.
   j. Review all plastic substitutions on planes.
   k. Design for plastics on new planes.

Plans were laid for committee activity to assist in this N.A.F. program.

The technical committee met on May 4, 1942, with representatives of the office of the Secretary of the Navy, the Naval Aircraft Factory, the Bureau of Standards, the Directorate of Photography, the Army Air Corps, the Signal Corps, the Engineer Corps and the Quartermaster Corps. The relation of the technical committee to the Government-industry committee being established by the Aeronautical Board was discussed. Pressing problems of the representatives were discussed. Many of those presented will clear through the Government-industry committee after its organization. Meanwhile it was suggested that such problems could be addressed to the technical committee which would either answer them or recommend companies or individuals in a position to do so. To make this service available to all interested Government departments, the technical committee has requested the Secretary-Treasurer to write the Secretaries of Agriculture, Commerce, Interior, Navy and War offering the services of the technical committee and suggesting that directives be issued to their organizations calling attention to this.

During this same period, the chairman of the technical committee has been serving as consultant on plastics to the Ordnance Department. The Ordnance Department is substituting plastics for strategic materials wherever feasible. In the Small Arms Division plastics were adopted as a standard substitute for several handles and grips. In the Artillery Ammunition Division, most projectiles have too high angular and linear accelerations to use plastic parts. However, on a low velocity trench mortar shell, plastic fuze parts have proved satisfactory and are now standard for procurement. Measurements on parts from sample molds indicated tolerances were too close and resulted in the establishment of more reasonable tolerances. Assistance was given in the preparation of the applicable specification AXS-698. Plastics have been adopted as alternate materials on some booster tubes. The use of plastics as knobs and hand wheels in the Artillery Division was recommended, also the use of plastics on some parts for tank and combat vehicles.

The immediate, short-term program of the technical committee comprises:

1. Establishing nomenclature and classifying materials.
2. Accumulating available engineering data for the use of the aeronautical Government-industry committee.
3. Giving all possible immediate assistance to Government departments in their substitution program.

The long-term program of the committee is one of standardization. The committee believes that the industry will greatly benefit by the unification and stabilization obtained through standardization of established materials and practices; that such standardization will be a substantial foundation for the proper application of plastics which will ensure at the conclusion of the war the attainment and retention of the business which the industry should have.

Standardization projects should be scheduled only on request from responsible sources in industry. It must first be decided whether such a standard is generally desired and would be of practical value. If this decision is affirmative, data on current practice and requirements must be gathered and tabulated, from which a preliminary recommendation is to be prepared and circularized to the industry for constructive comment and criticism. From this comment and criticism a final recommendation is to be drafted. Before adoption and publication as a standard, the recommendation must be approved by the sub-committee to which it was assigned and by the technical committee. Standards should be approved and adopted only on evidence of acceptability by the industry at large. Standardization of projects still in a development stage should not be attempted. Progress in practice should be followed by revision and extension of standards.

Technical committee publications will probably be:

1. S.P.I. Standards—These shall be specifications based on sound, established engineering practice.
2. S.P.I. Recommended Practices—These shall be specifications based on sound engineering principles and are intended as guides toward standard engineering practice.
3. S.P.I. General Information—This shall include data, usually bearing on S.P.I. Standards or Recommended Practices, and of sufficient value to warrant publication by the Society.

The technical committee is establishing sub-committees to work on this program. The sub-committees will be kept small to expedite the work. They will be composed of producers and processors with such other competent interests as may be needed. Because of their small size it will not be possible to have all interested companies represented. However, on individual problems the sub-committees will call for outside assistance and the technical committee wants, and expects to receive, the wholehearted cooperation of each one of you.

The technical committee will handle most engineering problems and act as the executive committee. There will be a sub-committee on thermosetting molded plastics headed by Mr. Garson Meyer of the Eastman Kodak Co.; a sub-committee on thermoplastic molded plastics headed by Dr. G. M. Kuettel of Du Pont; probably a sub-committee on laminates; a sub-committee on resin adhesives headed by Dr. M. H. Bigelow of the Plaskon Co.; and a sub-committee on publications headed by Mr. W. T. Cruse. The scope of activity of the first four sub-committees will be to establish nomenclature, advance uniformity in testing and obtain engineering data to be incorporated into S.P.I. Standards or S.P.I. Recommended Practices to promote interchangeability, eliminate variety and facilitate the production and use of the respective classes of materials. The scope of activity of the publications sub-committee is obvious.

★ ★ ★

The newly appointed statistician of the Society, John O'Herron, read a report of the statistical research and analysis being carried on by the Society and showed slides of various charts and graphs compiled from such data. These covered materials, machinery, wage rates, etc. Several are reproduced on the next page.

Because of the timely interest and importance to the entire industry of developments in the raw materials situation, the following telegram sent from MODERN PLASTICS Washington Bureau was read to the members:

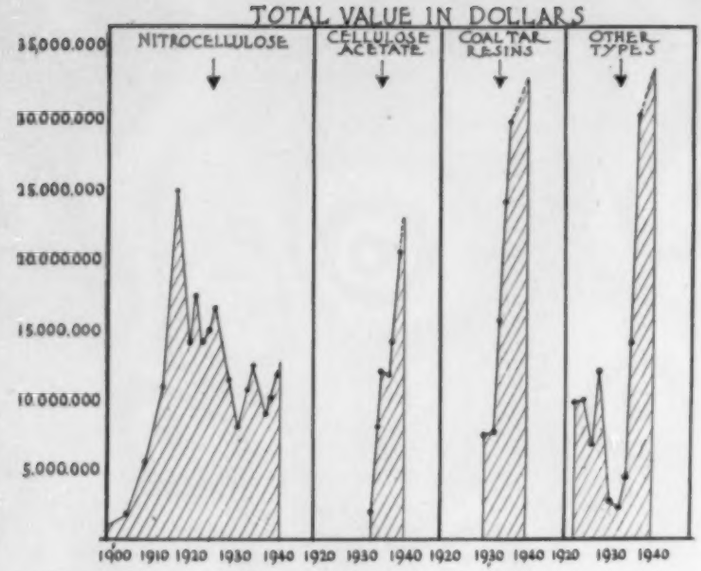
OVERALL ALLOCATION OF PHENOL TO PLASTICS MANUFACTURE MAY BE CUT VERY LITTLE BELOW APRIL OR MARCH (WHICH WERE ABOUT 10 PERCENT BELOW FEBRUARY) USAGE IN MAY ALLOCATIONS. HOWEVER, SOME INDIVIDUAL MANUFACTURERS MAY BE CUT RATHER SHARPLY BECAUSE THEY ARE NOT WORKING ON HIGH PRIORITY RATED ORDERS.

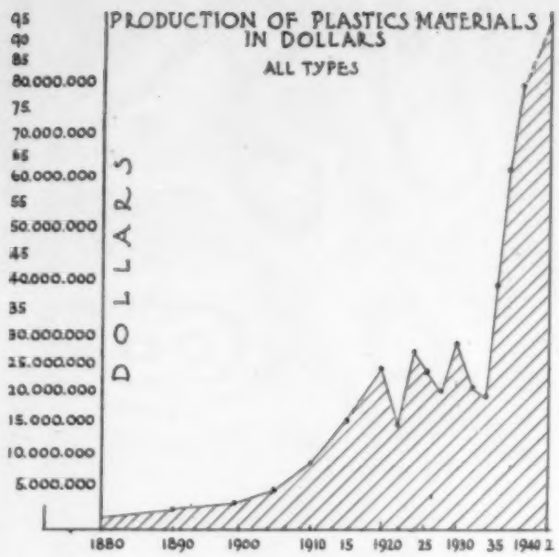
FURTHER THE RATINGS NECESSARY TO GET PHENOL WILL PROBABLY GO UP. THUS, FOR EXAMPLE, WHILE AN A-10 MIGHT HAVE GOTTEN PHENOL PREVIOUSLY, IT MIGHT TAKE AN A-8 NOW. THIS IS JUST AN ILLUSTRATION OF WHAT I MEAN AND NOT NECESSARILY AN ACCURATE PICTURE OF THE RATING NECESSARY TO GET PHENOL.

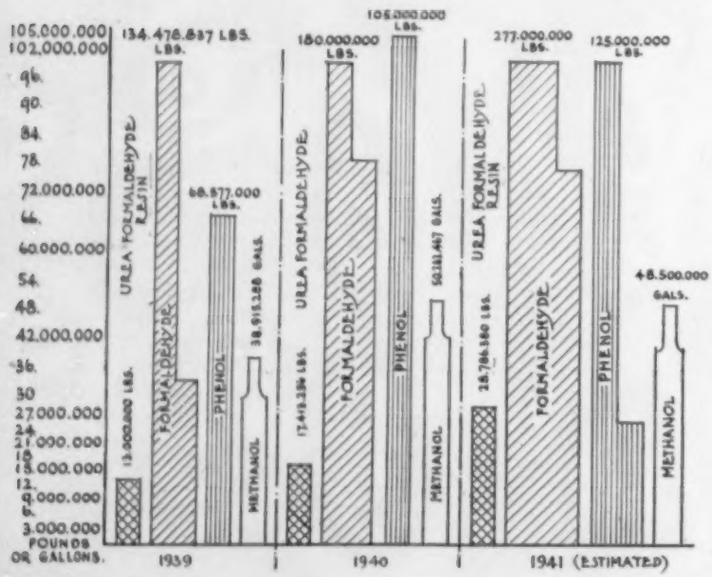
AGAIN WE MUST HAMMER HOME THAT PLASTICS MANUFACTURERS MUST TURN INCREASINGLY TO WAR PRODUCTION AND BREAK DOWN THE BARRIERS IN FRONT OF THEM WHICH ARE KEEPING THEM FROM OBTAINING WAR CONTRACTS. IF THEY WANT TO STAY IN BUSINESS, WAR IS THE ONLY ULTIMATE CONSUMER THAT THEY SHOULD REALLY PRODUCE FOR.

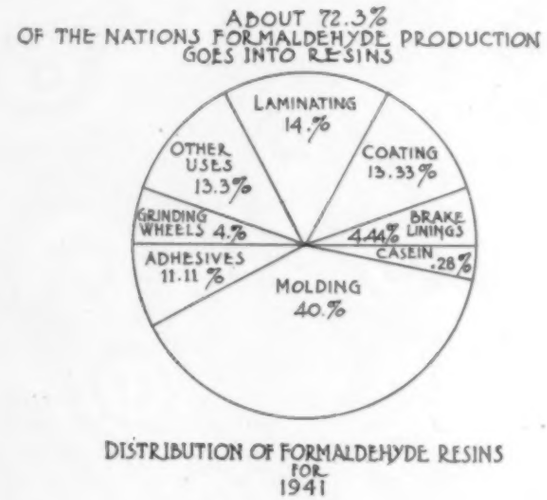
Raymond R. Dickey

An important action taken was the decision to form a Plastics War Planning Committee as outlined above in Mr. Higgins' speech. The following were suggested to serve on the board:









Charts Showing Plastics Production, etc., Based on S.P.I. Statistical Reports

S.P.I. Officers and Directors—1942–43

Ronald Kinnear, Charles A. Higgins, Leslie B. Gillie, George Scribner, George P. Anderson and William T. Cruse. The committee will hold a meeting later in the month to formulate a definite program.

A resolution was passed to record the appreciation of the Society for the enthusiasm and foresight of Gordon Brown, Bakelite Corp., who founded S.P.I., and through whose efforts the Society has reached maturity.

The election of officers concluded the meeting. Ronald Kinnear, Niagara-Insul-Bake Specialty Co. and Elmer C. Maywald, Chicago Molded Products Corp., were unanimously reelected president and vice-president, respectively. William T. Cruse, the present executive secretary, was made executive vice-president. Frank Shaw, Shaw Insulator Corp., and W. H. Frylind, Erie Resistor Corp., were reelected to the Board of Directors and the following new directors elected: Hans H. Wanders, Northern Industrial Chemical Co.; Horton Spitzer, Plaskon Co.; Howard S. Bunn, Carbide and Carbon Chemicals Corp.; William Joslyn, E. I. du Pont de Nemours & Co., Inc.; and Donald Boschert, Dunning & Boschert Press Company.

Bank from beryllium

Although production of such plastic items as novelty souvenir banks is being postponed for the duration, the die construction, the use of beryllium copper molds, and molding technique involved are of sufficient technical interest to merit a story at this time.—ED.

GETTING the public to buy advertising merchandise is no mean accomplishment. But the Howard Johnson chain of restaurants has applied the same technique used to sell its 28 ice cream flavors and home style cooking along the Eastern seaboard to promoting a small molded plastic souvenir bank.

The idea of using a bank for advertising purposes was not new, of course. But Howard Johnson made this bank so attractive that it could be sold as a piece of merchandise. These plastic savings banks are replicas of the typical Howard Johnson roadside restaurant building, a New England type cottage with white walls and an orange-colored tile roof.

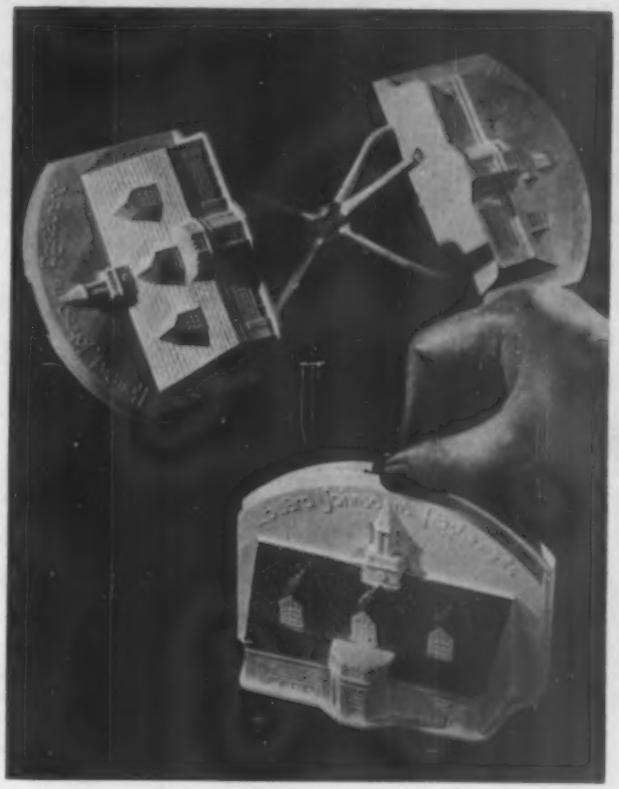
The banks are produced of cellulose acetate on a 4-oz. machine. The molding, consisting of a male and female half, forming a single bank at one shot, weighs, plus sprues and runners, $2^3/_4$ oz. The cycle is about thirty seconds.

After considerable experimentation for maximum speed the nozzle size determined was $^3/_{16}$ of an inch. For excellent filling characteristics, sprues and gates were made of liberal size and runners run directly into cavities without restriction. To avoid air trap and poor welds, double gating was specified. In cooling, cavities and forces were channeled instead of following the usual practice of channeling the chases. No venting was employed.

To achieve maximum speed of production and economy so that the bank could be sold at a reasonable price, the chief engineer of the molding company devised a number of manufacturing innovations. In designing the dies, he chose beryllium copper instead of steel, to allow a large amount of detail to be incorporated in the dies at a minimum cost.

The beryllium copper dies allow a somewhat faster machine cycle—almost three banks per minute—because they lose heat more rapidly than steel. Although the cost of these dies in beryllium copper was about half that of the same job in steel because expensive engraving was eliminated, the die life has proven to be almost equal that of steel.

A sample or pattern bank was first cast in plaster. This pattern, after approval by the customer, was then reproduced in cast iron by the regular foundry practice, making a cast iron hub representing one-half of the bank. This cast iron hub was then polished, checked for registration and the male locating pins around the edges of the die added to provide male and female halves for the bank. A steel frame, having the overall outside dimensions of the finished beryllium casting, was then set in place over the die and filled with molten beryllium copper upon which pressure was applied by means of a hydraulic press. When chilled, the casting so made was removed from the die and frame, placed in the position of the original cast iron die, and a beryllium copper force was then cast (by the method outlined above) into the beryllium cavities halves. Upon removal, the force was cut down to allow for material thickness, forming the completed detail dies quickly and accurately. Both cavities and forces were then economically heat treated (hardening of beryllium copper takes place in two stages, the first around 1450 deg. F., and the second around 650 deg. F.) and inserted in master backing plates with the sprues and runners cut in the steel to join the runners in the beryllium copper insert.



Tiny window panes, roof tiles and other minute detail of a coin savings bank molded of cellulose acetate are achieved at low cost by the use of beryllium copper dies

For ease of assembly and perfect matching of the two parts of the bank, the knockout pins impinge on the flanged edges of the bank which are later concealed in cementing the two halves so that no knockout marks show in the finished bank. The male locating pins for speeding assembly of the banks are concealed on the inside of the female half. The male and female halves are cemented together and assembled in jigs. These automatic clamping fixtures are specially made to close accuracy and are cam-operated for fast production, the jigs holding just long enough for proper setting. After setting, the bank is sanded and buffed on the bottom for smoothness. By such grinding after cementing, the grating points as well as a bottom flange are completely removed, so the completed bank has no die or assembly marks on it and appears unusually well finished. Then the banks are ready for painting.

Constructed for fine accuracy, special mats which work on hinges are swung into place and cover the two dormer windows and the steeple while the roof is sprayed with a special orange paint created to match the original roof color.

Credits—Material: Tenite. Molded by Plastics Engineering, Inc., on a Reed-Prentice injection press. Engineered by E. H. Trump. Dies by Ferriot Brothers

Lignin plastics development

War effort gives impetus to expanded use of lignin both as a material and as an extender

FOR many years the disposition of ligneous liquor, a by-product of paper-making by the sulfite process, has been a distinct problem. Paper mill laboratories, as well as individual chemists, have spent much time and energy on searching for uses for this by-product material. Some time ago it was found that lignin material itself, which acts as the natural binder to bond the cellulose fibers in wood together, incorporated plastic qualities which could be utilized in industry. Intensive as well as comprehensive research followed; and although there is still a great deal not known about lignin, it is now and may become increasingly more important to the plastics industry as knowledge on how to use it broadens. It is of particular significance today because of the restrictions placed on the use of phenol and formaldehyde.

The tremendous volume of pulp required by the paper industry assures both a plentiful and economical supply of the by-product material, lignin. Essentially a thermoplastic material, it has been limited in its use in the pure state by the fact that it is not yet available in a form satisfactory for injection molding work. On the other hand, lignin reacts with amines and furfural (as well as with phenols) to form resins of the thermosetting type. Consequently, as long as phenol and formaldehyde are on the critical list, many additional uses may be found in laminating and impregnating varnishes and molding powders for lignin, either with or without chemical modification.

At the present time, lignin is available commercially in at least two forms: A lignin plastic pulp which can be used for making laminated or molded products, and lignin resins in powder form for extending phenol-formaldehyde resins for laminating varnishes, molding powders and other applications. Lignin plastic pulp can be made into a sheet on a paper machine for laminating purposes. Such laminating paper can be molded in the same type of equipment as is commonly used for molding laminated phenolic-impregnated paper, and the resultant sheet or board incorporates high strength, low water absorption and good electrical properties.

Since magnesium, aluminum and other metals have become critical, this lignin laminated material has been rather widely used by all types of foundries for pattern plates. It is available in various thicknesses up to 1 in. or more in standard or special flask sizes. The standard pattern plate is octagonal in shape and has 1 in. allowance for flask and $2^1/_2$ in. for ears. Special plate sizes and shapes can be supplied, and stock boards 46 in. by 46 in. in various thicknesses are available. These stock boards can be readily milled, sawed, drilled, tapped, turned, filed, sanded or otherwise machined and, in general, metal working tools can be used. In drilling, the material should be backed to obtain a clean hole without a break-through crater.

These lignin laminated boards incorporate plane parallel surfaces, and the standard finish is a fine grain texture which prevents sand slippage and sticking. They can also be furnished in a mirror or satin finish when specified. The material is free from pits or other defects, is non-corrosive and will not sweat. Surface hardness is sufficient to prevent excessive abrasion and indentation by sand or flask. The dense uniform structure and excellent strength properties of lignin laminated render it satisfactory for use with vibrators. Being water-resistant, it will not warp, crack or swell when exposed to high humidity conditions or when in contact with wet sand. Lignin laminated can be shellacked, lacquered or painted if desired. For filling countersinks and similar work, any of the commonly used air-setting fillers is satisfactory, since their adhesion to the laminated material is good. Lignin laminated should not be subjected to constant temperature in excess of 200 deg. F., as exposure to such heat continuously will result in the formation of small blisters on the surface. In pattern work, care is required in soldering metal parts, gates, etc., mounted on the plate.

The natural lignin laminated product without phenolic or other synthetic resins either in the core or on the surface is reported to have the following properties:

Specific gravity	1.36–1.40
Specific volume, cu. in. per lb.	19.8–20.5
Flexural strength, lb. per sq. in.	17,000–21,000
Tensile strength, lb. per sq. in.	8,000–12,000
Compressive strength, lb. per sq. in.	25,000–35,000
Impact strength, ft.-lb. per in. of notch (Izod)	0.6–0.8
Maximum heat resistance, deg. F.	190
Surface hardness, Brinell	40
Water absorption, percent for 24 hr. immersion	
$^1/_{16}$ in. thickness	2–4
$^1/_8$ in. thickness	1.5–2.5
$^1/_4$ in. thickness	0.75–1.5
$^1/_2$ in. thickness	Less than .75
Dielectric strength, volts per mil	
Short time test	
$^1/_{16}$ in. thickness	725
Dielectric strength volts per mil	
Step by step test	
$^1/_{16}$ in. thickness	500
Dielectric constant	5.85
Power factor	0.041
Loss factor	0.24
Arc resistance, seconds	183–190

All the above properties were determined by test made in accordance with the appropriate A. S. T. M. methods. The tests for dielectric constant, power factor and loss factor were made on a $^1/_{16}$ in. thickness at a temperature of 28.5 deg. C. and a relative humidity of 38 percent at radio frequency of 1 megacycle per second. For the dielectric strength tests, the current was supplied by a 20 kv.-a. 100 to 200 kv. transformer receiving energy from a 60-cycle 120-volt circuit, the wave form of which is practically a sine curve. The arc resistance tests were made on a $^1/_{16}$ in. thickness under the continuous arc at 10 Ma. and temperature during test 26–29 deg. C. at relative humidity of 38–45 percent.

By the application of a light coating or surface sheet of phenol to one side of the natural lignin laminating paper prior to molding, a general improvement in some properties, particularly heat resistance, can be obtained. Many laminators are making use of lignin laminating paper both with and without the addition of phenolic resins for production of laminated products in electrical, mechanical and decorative fields.

The plastic lignin pulp can also be ground and plasticized to produce either a thermosetting or a thermoplastic molding material. Greatest emphasis has been placed on the development of a thermosetting lignin molding material that can be molded under similar conditions and in the same molds and presses as are now used for the phenolic-type molding powders. For this use, the lignin plastic pulp is ground to a fine consistency and plasticized with phenolic resin. The amount of phenolic resin that is required with the ground lignin pulp depends to a large extent on the requirements as to plasticity and other properties, and ranges from 15 to 28 percent on the weight of the lignin pulp material. Such lignin molding powder compositions are stated to yield products that have properties similar to those of products made from phenolic molding materials incorporating 40 to 50 percent phenolic resin. As an example, it is claimed that a lignin powder containing 23 percent phenolic resin and 77 percent of the ground lignin pulp, when molded under 2000 lb. per sq. in. pressure at about 140 lb. steam pressure and pulled hot, would have a flexural strength of 10,000 to 11,000 lb. per sq. in., an impact strength of 0.4 ft.-lb. per lineal inch of notch (Izod) and a water absorption of 0.5 percent for a 24-hour immersion. Some laboratory-prepared samples of this lignin molding powder have been forwarded to various molders, who report that the material is satisfactory for radio cabinets, closures, record player turnover arms, radio tube sockets, scale housings and similar applications.

There is a considerable tonnage of this lignin plastic pulp available per day, and if it were all utilized for molding work it could increase the available molding powder for the plastics industry by approximately 40,000 lb. per day. Such additional poundage would assist the plastics industry materially and utilize some of the press and molding equipment which has been idle since the M-25 formaldehyde order was issued.

The lignin resin is used primarily at present as an extender for phenol-formaldehyde resins in the manufacture of impregnating varnishes and molding powders. These lignin resins are in powder form and can be mixed directly with the phenolic resins, replacing up to 50 percent of the phenolic solids without greatly affecting the properties of the molded products. The mixing of lignin with phenolic resins for molding compositions must be taken care of by material suppliers or by molders who are equipped to mix their own molding materials. Such phenolic-lignin compounds will set during the molding operation, thereby permitting hot removal of the molded product from the die.

Recently, samples of molded and laminated lignin plastics were tested by the Organic Plastics Section of the National Bureau of Standards. The lignin molding composition was reported to contain 23 percent phenolic resin and 77 percent of lignin material. Besides these two principal ingredients, calcium zinc stearate was present as a lubricant to the extent of about 1 percent of the weight of the composition. The sheets of laminated lignin plastic tested were of three thicknesses: 1/8, 1/4 and 1/2 inch. These were described as prepared with natural lignin containing no phenolic resins either in the core or on the surface. A sample of a laminated lignin product made with surface sheets impregnated with phenol-formaldehyde resin was also tested in 1/2 in. thickness.

The Izod and flexure specimens were conditioned at 25 deg. C. and 50 percent relative humidity, and were tested in the conditioning atmosphere. The tests were conducted according to the A. S. T. M. methods for testing molded and sheet insulating materials. The water absorption of the molded material was determined for specimens 6 by 3 by 1/4 in., and that of the laminated material for specimens 1 by 3 in. by the thickness of the sheet. The tentative A. S. T. M. method, D570–40T was followed in conducting the water absorption determination. The results of the tests are as follows:

			No. of
Flexural strength, lb./sq. in.	Average	Range	specimens
Lignin molded	10,100	9240–10,940	12
Lignin laminate—edgewise	17,290	16,810–17,640	6
Lignin laminate—flatwise	17,020	16,310–17,670	6
Lignin laminate with P. F. faces—edgewise	16,260	16,020–16,700	6
Lignin laminate with P. F. faces—flatwise	16,240	15,690–16,960	6
Specific gravity (determined on flexure specimens)			
Lignin molded	1.40	1.37–1.44	12
Lignin laminate	1.41	1.40–1.41	12
Lignin laminate with P. F. faces	1.41	1.40–1.41	12
Izod impact strength, ft.-lb./in. of notch			
Lignin molded	0.34	0.28–0.43	12
Water absorbed, 24-hr. immersion, %			
Lignin molded	0.42	0.41–0.43	3
Lignin laminate, 1/8 in. thickness	2.84	2.70–3.12	2
Lignin laminate, 1/4 in. thickness	1.17	.....	1
Lignin laminate, 1/2 in. thickness	0.70	.....	1
Lignin laminate with P. F. faces, 1/2 in. thickness	0.58	.....	1
Dimensional increases during 24-hr. immersion			
Length, %			
Lignin molded	0.05	0.03–0.07	3
Lignin laminate, 1/8 in. thickness	0.11	0.10–0.13	3
Lignin laminate, 1/4 in. thickness	0.03	.....	1
Lignin laminate, 1/2 in. thickness	0.00	.....	1
Lignin laminate with P. F. faces, 1/2 in. thickness	0.03	.....	1
Width, %			
Lignin molded	0.05	0.00–00.7	3
Lignin laminate, 1/8 in. thickness	−0.10	−0.10	3
Lignin laminate, 1/4 in. thickness	0.00	....	1
Lignin laminate, 1/2 in. thickness	0.19	....	1
Lignin laminate with P. F. faces, 1/2 in. thickness	0.00	....	1
Thickness, %			
Lignin molded	0.27	0.00–0.40	3
Lignin laminate, 1/8 in. thickness	2.67	1.61–3.97	3
Lignin laminate, 1/4 in. thickness	1.18	.....	1
Lignin laminate, 1/2 in. thickness	0.80	.....	1
Lignin laminate with P. F. faces 1/2 in. thickness	0.19	.....	1

References

Plastics Catalog 1942, p. 138 ff.
Modern Plastics Catalog 1941, p. 116 ff.
Robert M. Boehm, "Lignin Plastic," MODERN PLASTICS, Oct. 1939, p. 65 ff.
Guy C. Howard, "Lignin Plastics Created from Pulp Liquor Wastes," MODERN PLASTICS, Nov. 1939, P. 96 ff.
Gordon M. Kline, "Lignin and Lignin Plastics (A Review)," MODERN PLASTICS, Apr. 1937, p. 39 ff.; May 1937, p. 46 ff.

Paint color calculator

A major headache of commercial painters is caused by difficulties in matching colors and mixing paints in exact proportions. The Dural color calculator, which measures accurately any amount of liquid poured into a container, has been developed for just such calculations. It is claimed that the gage can be set accurately to measure as little as $^1/_{64}$ oz., so that in a 1-qt. container it will measure amounts as small as $^1/_{1000}$ of a part.

The gage, which is set on top of the can, is made entirely of plastic materials. The square measuring rod is of clear acrylic, selected because of its light-conducting qualities. When liquid poured into the can touches the base of the rod, it interrupts the light rays, thus signaling that the desired level has been reached. The rod is calibrated with 32 embossed markings in different colors on all four sides for pints, quarts, $^1/_2$gallons and gallons, corresponding to the color formula bases.

The rod is adjusted by turning the micrometer setting arm which is fastened to the rod through the bushings which support the rod on the base. Bushings are of molded phenolic and the base itself is laminated, with phenolic top and bottom surfaces and a urea core. Readings for fractional settings are engraved on the black top layer and show up in white.

Credits—Materials: Lucite rod, Bakelite laminate. Manufactured by Sewall Paint & Varnish Company

★ PRODUCT DEVELOPMENT ★

Plastic-walled shower bath

For decades, American bathrooms have been gawked at admiringly by visitors from lands where ablutionary rites are more rigorous. A recent contribution to the warmth and comfort of the U. S. bather is a shower cabinet with plastic wall panels which remain at room temperature; will not, on winter mornings, be cold and clammy to the touch. The manufacturer, looking for a material that would not rust, peel or leak, chose a wood fiber base plastic, had it molded in flat sheets 4 ft. by 12 ft. at 375 deg. F., cut to size and finished with a triple coat of synthetic resin enamel baked at 300 deg. F. The finished panels fit snugly into steel uprights, black enamel steel top band and porcelain steel receptor base.

The entire unit, complete with fixtures, may easily be assembled by one man, it is claimed, in a space as small as 30 sq. in. in any home, hotel, factory, bathhouse, club or tourist camp where there are water connections. The plastic panels are interchangeable for left, right or back water supply, and no nuts or bolts are required to hold them in place. Laboratory tests are said to have proved that they do not absorb water, will not rust and are acid-resistant. Their smooth, white enameled surfaces are easily kept clean, and the manufacturer states that their assembly is tight and leakproof. The unit is shipped knocked down so that it is ready for immediate installation.

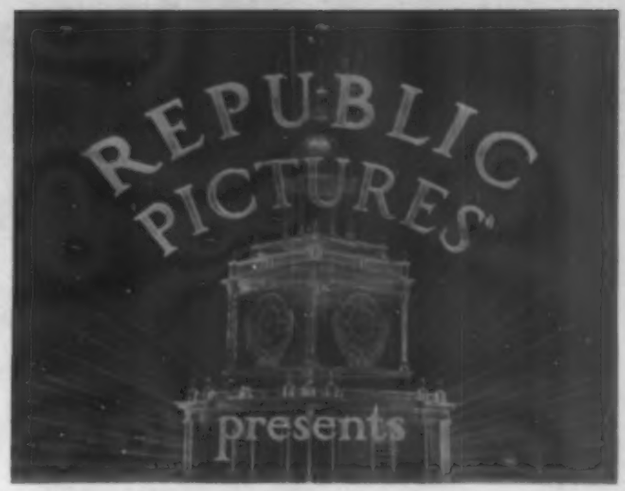
Credits—Material: Hardboard, by U. S. Gypsum Co.

Hollywood production

In the creation of the make-believe world which affords Americans their favorite relaxation—the movies—scores of plastics have been used on and off the set. One company has taken advantage of the dramatic effects obtainable with clear methyl methacrylate for its illuminated motion picture trademark, a miniature Independence Hall, which stands 6 ft., $5^1/_2$ in. high on a base measuring 30 in. by 30 in.

The intricate plastic replica was skillfully fabricated. In the walls of the base, the boarded and brick effects were achieved by a series of saw cuts which leaves the methyl methacrylate a white, translucent color. The walls are $^3/_8$ in. thick, while windows are thinner and the upright columns considerably heavier. Capitals atop the columns were hand carved, cemented in place. Window-panes are divided by saw cuts, and the casings were mitered and then cemented in. Thick cornices top the walls.

Joining the clock faces are shaped columns with hand-carved capitals, while the clock face itself has sand-blasted numbers and lines, chromed metal hands and a hand-carved acrylic wreath cemented to the face. The arched walls supporting the domes were sand-blasted, filed, sanded and polished prior to being mitered and cemented. Domes were hand carved from solid pieces, polished and the brick effect added by hand-scribing the material. Atop the smaller dome stands a chrome-capped plastic pier with chrome spire extended through to a small ball and a winged arrow weather vane.



Special methods were required to counteract the shrinking propensities of the acrylic adhesives in cementing the large surfaces, and the successful techniques used in this pre-war display are now playing a part in forming huge airplane noses, turrets and other enclosures from these plastics.

Credits—Material: Lucite. Fabricated by Swedlow Aeroplastics Corp. for Republic Pictures, Inc.

PRODUCT DEVELOPMENT

Revolver grip

The aftermath of an air raid brings with it an urgent need for adequate police protection. With military production the first aim of all arms plants, weapons for the police and home defense units must be produced without interfering with the war program. To meet this situation, rapidly produced injection molded cellulose acetate pistol handles have been made to replace wooden types.

In addition to being manufactured more rapidly than the wooden handle, the plastic grip is produced at a lower cost per unit. Complete, one-piece handles are produced two at a time, in one molding operation, all in the space of 60 seconds. No final finishing is needed, except to remove the gate scrap as shown in the lower photo. The polish and hand-carved pebbly finish are acquired from the walls of the mold.

The plastic has excellent uniformity and dimensional stability to assure even weight and balance and absorbs very little oil—of particular importance since firearms inevitably come in contact with oily rags. Its toughness, high impact strength and weather-resistance are added qualities which enable it to pass the severe service tests.

Pistol users place great emphasis on the "feel" of a pistol, and the solid, low-heat conducting plastic handle is particularly pleasing in this respect.

Credits—Material: Tenite, Lumarith, Molded by American Insulator Corp. for Harrington & Richardson Arms Company

PHOTO, COURTESY U. S. ARMY SIGNAL CORPS

Mountain troops, dressed in white parkas for camouflage, learn to fire from a prone position without tangling in their skis

"Working" skis for U. S. troops

UNTIL the present war began, to the great majority of Americans a ski was a long pointed wooden runner for attaching to persons who enjoy going outdoors in zero weather and falling into snowdrifts. All skis looked alike, and their only variable attribute was a matter of pronunciation: they were either skēs or shēs, according to whether their owners spoke good American or affected the Continental. Now everyone who reads his newspaper knows that there are, occupationally speaking, two classes of skis: "play" skis—the Sun Valley kind—and "work" skis—the variety worn by the fighting men.

Turning out skis has never been a project of the general manufacturer of wood products. Good skis have always been made by specialists according to a definite pattern established many years ago, and there has been little change in their design or construction. Although the best play skis are of excellent grade and quality, skis for the armed forces must meet service requirements that "play" skis are not always called upon to approximate. They must be eminently serviceable, carry more than normal loads, take their wearers over unbroken trails and rough terrain, and do continuous duty with repairs limited to those which can be made with a small kit carried in the ski trooper's pack. The ski trooper is helpless in deep snow if his skis fail to function.

When the United States Army Quartermaster Corps required skis for our troops, the Allied Aviation Corp., makers of resin-bonded plywood aircraft, undertook the job of producing this type of equipment on a straight line production basis. This naturally required the complete overhauling of previous methods of ski manufacture. General practice had called either for a single piece of lumber of a specified thickness to be machined and formed to certain specifications, or for a laminated ski of sawed and seasoned lumber. The company, experienced in the processing of resin-bonded plywood, disregarded precedent and decided to make its "Aerofleet" skis of layers of veneer and resin-bond them, a method by which it was confident of producing a ski that would be stronger and give longer service.

Aerofleet skis are made by the Vidal process, one of several pressure tank processes devised for the bonding of wood veneers with a synthetic resin. The first step in the manufacture of skis after the selection of the desired type of wood (usually hickory) is the curing of the wood. Here the new skis have an advantage over the old type because the moisture content of a veneer is more easily controlled than is that of the thicker board or billet used in standard manufacture. Moisture content of the wood has a great effect on the ability of the ski to hold its shape and to give long service. When

the veneers are sufficiently cured, they are coated with a phenolic resin by passing them through a glue spreader—the ordinary procedure in the manufacture of plywood—and set aside until they are dry enough to handle. In the meantime, an insert made of pyramided layers of veneer has been pressed and machined and is ready to insert between the top and bottom layers, which run the full length of the ski.

In the foreground of Fig. 3 are the veneers for one ski fanned out: the three strips of veneer for the bottom; the insert, which is thicker at the footplate and tapers toward the ends; and three strips of veneer for the top, all ready to lay up on the mandrel, or ski form. On the mandrel shown in the figure, two pairs of skis may be laid up, since it is the same on both sides. When the six veneers and insert are placed in order on the mandrel, they are taped down, which draws the entire assembly to the shape desired in the finished ski. Several of these mandrels are placed on a long flat car, covered with a rubber blanket and wheeled into the pressure tank to be cured under heat and pressure. After a definite period of time the tank is opened and the skis removed. They have literally been hot molded into the desired shape and stabilized by the thermosetting resin against warpage caused by changes in humidity and temperature or contact with water. They are as truly molded as a phenolic molded plastic part. The skis are now ready for trimming, grooving and lacquering.

At the present time, metal strips are applied to the bottom edges of the skis, to give them longer wear and to enable them to grip the snow on sharp turns. It is hoped that it will soon be possible to eliminate these metal edges through the use of new types of plywood developed by the Forest Products Laboratory of the U. S. Department of Agriculture, located at Madison, Wisconsin. Tests recently made by technicians at the Laboratory indicate that we shall soon have qualities of hardness in plywood never before found in ordinary, untreated wood. A flat white lacquer or paint is applied to the top of the ski (see Fig. 4), for camouflage effect.

In the service it has been found that, while these skis must be given the usual waxing treatment, it has not been necessary to seal them or hold them in shaping clamps when not in use. The phenolic resin forming the bond for the layers of veneer actually waterproofs and weatherproofs them, and plies will not separate in sub-zero temperatures or in boiling water. As a unit, the ski will support tremendous weight without breaking and will withstand the hardest kind of usage.

Another manufacturer of skis who uses the Vidal flexible bag molding technique is Molded Wood Products Co., which is now making toboggans for Army mountain troops by the same process (see Figs. 5 and 6). The separate layers of veneer for this company's skis are coated with phenol-formaldehyde resin adhesive and laid over a wooden mold shaped to the curvature of the upper side of the skis—just the reverse of the first mandrel described, which fitted the under side. The veneers are thin enough—$^1/_{16}$ to $^1/_8$ in.—to follow the curve without breaking.

The entire assembly of mold and coated veneers is slipped into a flexible bag of natural or synthetic rubber which is closed and exhausted of all air by application of a vacuum.

(*Please turn to page 108*)

PHOTOS, COURTESY DUREZ PLASTICS & CHEMICALS, INC.

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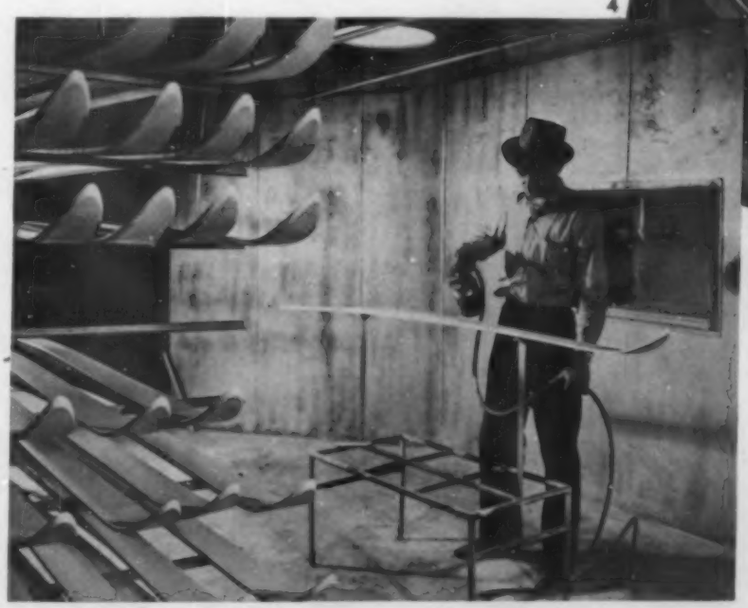

2—A pair of finished skis, showing the white, camouflaged top surface and the metal strips attached to bottom edges. 3—Resin-coated strips of veneer are laid up on the mandrel to be taken to the pressure tank, cured under heat and pressure. The thermosetting resin stabilizes them against warpage. 4—A white lacquer is sprayed on the top of each ski

1

2

1 A unique control system which keeps track of over a hundred tractor-trailers within the New York City area has been developed for the Railway Express Agency, Inc., by Chief Clerk C. H. Ryan. On a special control board built with Formica sheet stock and Bakelite molded mechanical and electrical parts, a single dispatcher can locate every single truck unit in operation. The framework of the board consists of 300 closely fitting blocks fabricated from black, non-glaring laminated sheeting. Across the board, stripes of the same material in red separate the various hours of each dispatcher's "trick" of 8 hours before the board. The control board has been operated continuously for nearly two years

2 Multiple fluorescent ceiling fixtures by F. W. Wakefield Brass Co. make use of formed translucent Textolite side panels to obtain soft light diffusion, good looks, economical design and construction. These translucent laminated sheets, $^1/_{32}$ in. and $^1/_{16}$ in. thick, are furnished cut to size and formed to shape, ready for assembly. The material is easily cleaned, does not collect dust caused by static, and its light weight reduces shipping and installation costs. The material may be used for louvers, troughs and windows in end plates as well as side panels

3 Athletic-minded spectacle wearers can now indulge in such strenuous sports as basketball, squash, handball, etc., without fear of breaking their eyeglasses. A lightweight, non-fogging visor, made of a single curved sheet of transparent Plexiglas supported against the forehead and cheek bones by sponge rubber pads, will protect fragile glass lenses. The plastic will not shatter if broken under extreme impact, but breaks into large dull-edged pieces

4 Little dippers, molded of acid-resistant, transparent Bakelite polystyrene by Kilgore Mfg. Co., are used in creameries to test milk. Chemists add to small measured amounts of milk 9 cc. of concentrated sulphuric acid which dissolves the casein and all other solid constituents except the butter fat. The percent of butter fat remaining in this measured amount determines the quality of the entire "batch." The plastic dipper is said to have reduced by 75 percent the breakage costs entailed by the use of glass, and to have reduced the entire cost of the testing operation by as much as 15 percent

5 All out on the home front! Inexpensive, durable whistles of bright molded plastic go on air raid duty, replacing metal ones. They won't tarnish, chip or discolor. Molded by Advance Molding Co. of Nixonite based on Hercules cellulose acetate flake

6 Transparent methyl methacrylate sections on Wilson Chemical Feeders allow immediate detection of air in the block which might disrupt the flow of chemicals. The clear Lucite blocks seen on the vertical cylinder at the left of the machine are unaffected by the chemicals employed, eliminating the need of protective lining. Such small feeders as this one are used for chlorination of water supplies, the feed of hydrofluoric acid for metal pickling problems, purification of sewage effluents and sterilization of swimming pools. The sturdiness of this material is an important factor in an industrial application of this type because it must withstand the high pressure in the feeders

7 Handy items of medical and first aid kits, body-temperature thermometers are safely protected in molded Durez cases. These sturdy cases, consisting of cap and tube, are produced in one operation. Outside threads on the tube and inside threads on the cap are molded in the plastic. The square section at the threaded end of the tube prevents rolling of the case, thus reducing loss through breakage, and also serves as a stop for the cap. Molded for Field Mfg. Co. by T. F. Butterfield, Inc.

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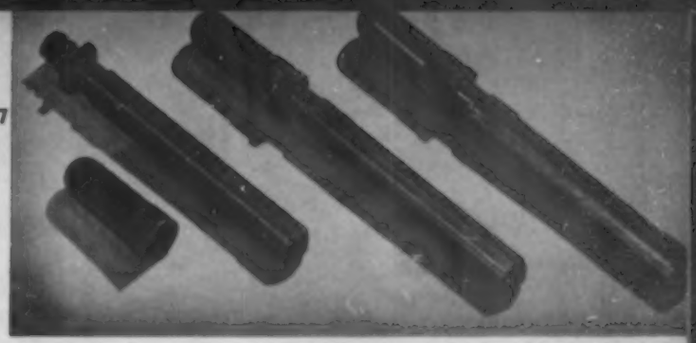

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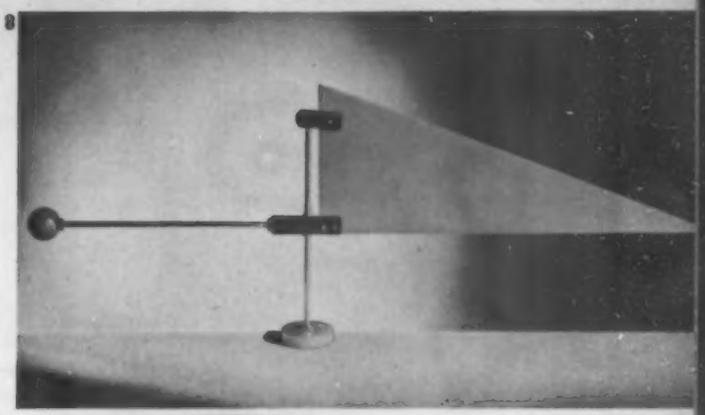

PLASTICS IN REVIEW

8 One sheet in the wind—Windetector II, aloft on the mast, tells the sailboat enthusiast "where the wind's coming from." The vane is cut from red Vinylite sheet which is light, weather-resistant and easy to see when running before the wind. Machined Catalin and Marblette cylindrical bearing blocks are shrunk and riveted to the vane. Base and counterweight are machined from cast resin also. Made by Lauren and Lauren, the plastic wind indicator replaces instruments made of brass or aluminum. Aside from the obvious importance of releasing strategic metals for vital war applications, this new device is so lightweight—1 1/2 oz.—that it has virtually no effect upon the stability of even so small a boat as the sailing dinghy

9 Gleaming white plastic counter and linoleum trim is part of the functional and decorative design of Alcoa S. S. Co.'s modernized waiting room and ticket office. Outlining magazine racks (top photograph) and information desk (below), the chip-proof, washable plastic strips protect linoleum edges against fraying and soiling and help to carry out the color scheme. Novel cross-section construction of the strips permits simple installation and prevents their working loose once applied. Extruded of Tenite by Extruded Plastics, Inc.

10 Spirally wound cellulose acetate sheeting in round, oval and square shapes forms a new electrical tubing service for wire insulation, cores for speaker field coils, bobbins, etc. Developed by Precision Paper Tube Co., tubing is produced from Lumarith Protectoid from 1/16 in. to 3 in. i. d. in varying wall thicknesses and in continuous lengths that can be cut to required sizes as it emerges from the winder. Besides clear transparent, the tubing is available with paper or fiber base with an outside layer of the plastic sheet. The electrical properties of this material have made possible other applications: for random wound ignition coils, spaghetti insulation for wire and protection for especially delicate metal parts such as micrometer handles

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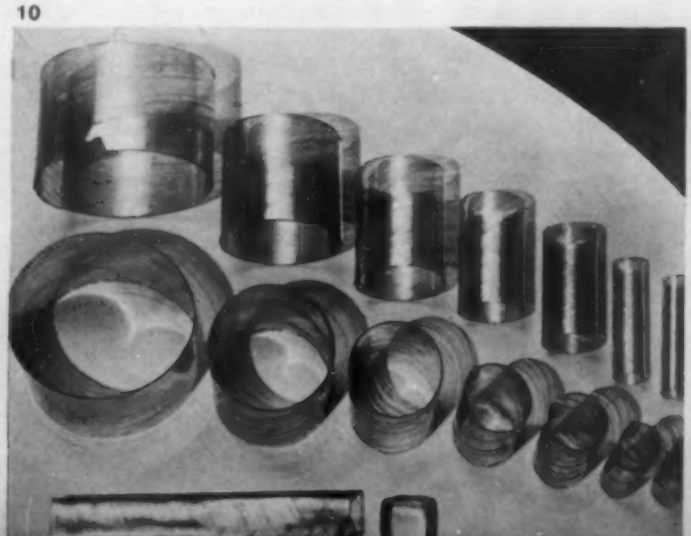


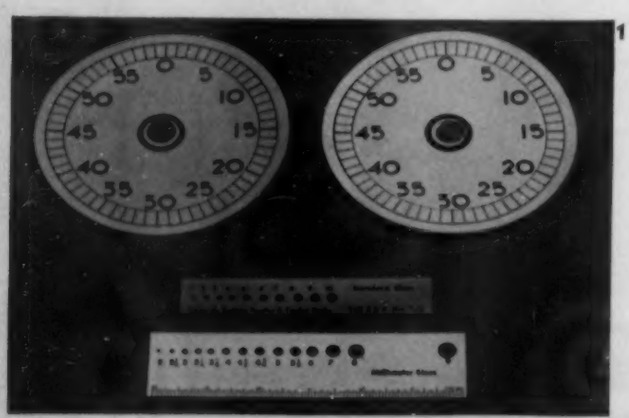
Printing and coloring acetate

IN his unwearying search for something new and strange, the modern American has come to fancy his calendars, greeting cards, charts and other printed memoranda on sheets of plastic instead of on humdrum paper or cardboard. But he doesn't want to pay too much for the luxury of the unusual.

Unhappily, the plastic sheet is a poor absorber of ink, and the printed word will soon rub off unless the sheet is protected by press-polishing or laminating. The former process, used on cellulose nitrate, is complicated and expensive, especially if the run is small. The latter, for use with acetate, involves imposing an additional thin, transparent acetate sheet on the one carrying the printing, and adhering it with a liquid adhesive or by heat and pressure. This process takes time and also adds to the cost.

A new method for protecting printed cellulosic sheet plastic short-cuts both of these processes by applying to the printed sheet a liquid film of cellulose acetate, coupled with a suitable solvent and plasticizer. This coating, applied by means of a recently developed printing process, is said to be superior in strength to either the laminated or the press-applied finish, and to present a more pleasing appearance. The process is not a lengthy one; and costs, it is claimed, are low, regardless of the size of the run. The coating is said not to peel off.

1—Printed acetate dials (top) and knitting rulers (below) are coated with a liquid cellulosic film which protects the surface. Darker samples are not coated. 2—White buttons and disks (center) were dyed with various colors which penetrate into the surface



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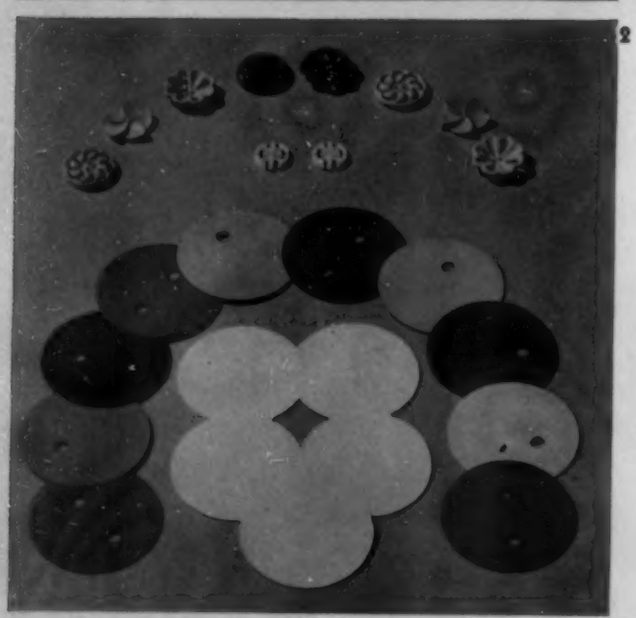

2

Practically all governmental radio apparatus, electrical control units and certain generators and engines are required to bear a plate upon which is printed, etched or engraved pertinent data such as wiring diagrams, serial numbers and explanatory charts. These plates were formerly made either of brass or aluminum. Printed acetate of suitable thickness which has been coated by this process has been approved by various warfare departments for these uses, thus freeing other vital materials for irreplaceable uses. Such charts and plates will undoubtedly find many additional applications in the war effort. They are unaffected by oils, dirt and atmospheric conditions and are reported to retain their legibility under severe conditions for a greater period of time than even etched metal.

These printed acetate plates can also be bent to conform to the shape of curved surfaces where necessary. Such shaping would be difficult with metal plates and practically impossible with plates of thermosetting material. As the softening point of the sheet cellulose acetate used is approximately 210 deg. F., plates of this type should not be used where severe heat conditions, with temperatures close to or in excess of this temperature, would be encountered; only metal plates would serve under such conditions. Gunnery charts, range indicators, computing tables and drafting instruments can be protected by this process. The printing may be employed on both sides of the sheet plastic if required.

The company responsible for this innovation has developed also a method of dyeing cellulose acetate and cellulose acetate butyrate which it says may be used for sheet stock, molded items and extruded shapes. In many cases, extruded shapes can be dyed in complete coils.

Crystal clear transparent materials become transparent colors by this dyeing process, and translucent or opaque materials in white or light shades may be given a wide variety of colors. Not a paint, spray or lacquer, the dye penetrates the surface of the plastic, and the resulting color is said to be indestructible. In fact, the piece can be buffed without removing the color. However, the dye does not penetrate completely through the material, as the manufacturer takes advantage of the hydroscopicity of cellulose acetate in effecting the dyeing process. Since the object to be dyed is not subjected to the action of solvent chemicals, its original finish is not altered, and it needs no subsequent polishing or processing.

We are told that the Government is using badges and identification disks dyed by the new method; and that buttons, buckles and other injection and compression molded plastic articles have been similarly colored with no damage to metal findings, attachments or fittings previously attached.

Credits—"Print-Cote" and "Printcolor," by Printloid, Inc.

1

1—Lovely, washable handbags are made from plastic-coated cord braided, woven, crocheted, knitted or power-loomed in brilliant colors. 2—Wire-like, coated cord, used to attach labels to electrical appliances, won't scratch their smooth, glossy surfaces

Coating extruded fibers

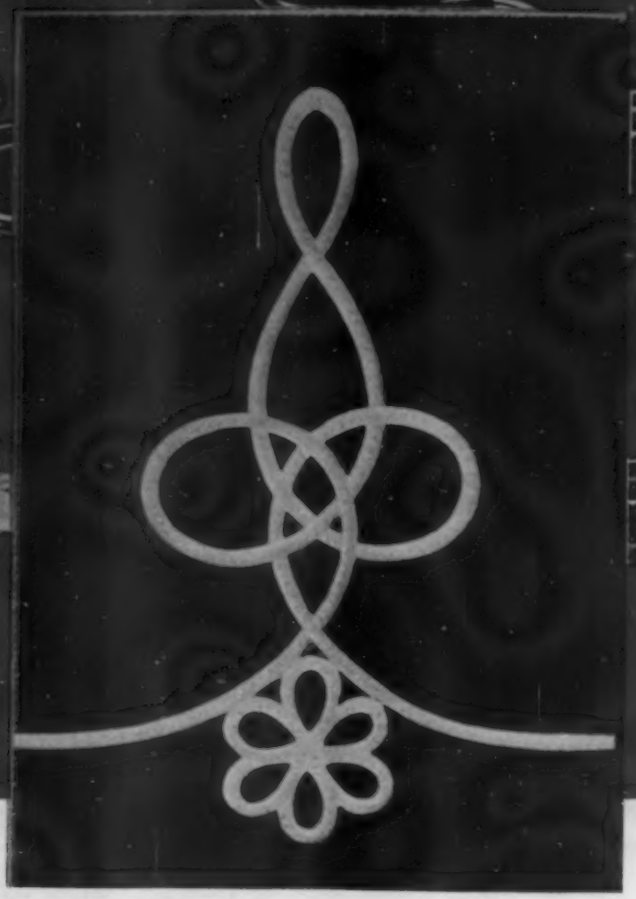
AMONG our memories of the Paris that was is the fascinating world of fashion, of lovely fabrics and fabulous creations. It is not surprising therefore to find the origins of a new plastic fabric in French patents. These modern fabrics are woven from plastic-covered fibers with cores of yarn, cord, tape or wire. They possess unique properties and are particularly interesting in view of the present shortages of such fibers as silk, wool and rattan.

Unlike the standard process of extruding thermoplastic-covered wire, which is well known, this new method is achieved through a combination of coating and extruding. The process, which has been kept secret, was originally a French development invented by Roumaizelles and Girard in France. The Société Rotin was licensed to extrude the yarns for belts and other applications. The Société Electro-Mechanique was licensed to extrude wire which would not deteriorate in colonial climates. Both patents were purchased for the Western Hemisphere in 1939 by Freydberg Bros. (now Freydberg Bros.-Strauss), who at first planned to develop a supplement to its line of fancy ribbons, cellophane wrappings, etc.

The more familiar method of extruding plastic-coated wire—largely used for insulation purposes—makes use of a special die and cross head on a standard extruding machine, engineered with cooling, drawing and rewinding devices. With this equipment, bare wire is fed into the insulating extruder and passes from the extruder through an annealing furnace which tends to relieve any possible stress marks and imparts added luster. Then it goes through a cooling trough, where water is sprayed on the wire, and finally around a draw-off capstan to a take-up reel.

The Freydberg-Strauss method differs from the above technique in that it applies a predetermined amount of plastic in a continuous, laminated coat. A series of dies is used on special machinery adapted from the French patents in such a way that, after each coating is applied and dried, the wire, cord or yarn support advances to the next die (which is slightly larger) for another coat until the desired thickness is attained. As many as 24 or as few as one coat may be applied. Many thin coats give flexibility to the finished product; one heavy coat gives a more rigid effect. The thickness of the coatings can be controlled (*Please turn to page 114*)

2 PHOTO, COURTESY WESTINGHOUSE ELECTRIC & MFG. CO.



ON DUTY with the Army, Navy and Marines

MILLIONS AND MILLIONS of Plaskon Molded Color buttons are being supplied for clothing in every branch of America's armed forces.

Good-looking buttons of blue, khaki and neutral white Plaskon . . . to harmonize with every type of garment worn in the service. The hard, non-porous surface of these buttons will not tarnish or corrode.

Strong buttons . . . that can withstand whatever rough-and-tumble action the day's duties may bring. Won't chip or shatter because molded Plaskon is strong and shock-resistant. Can withstand heavy laundering.

Exact buttons . . . thousands upon thousands of each type, molded absolutely uniform in every specification . . . to help speed application to clothing. All holes are exact, and all edges smooth and easy on thread.

These buttons for the boys in service are another example of the use of Plaskon for urgent wartime needs. Although these war requirements have reduced considerably the amount of Plaskon for civilian purposes, we shall be glad to help plan now for your future use of this versatile urea-formaldehyde plastic. Plaskon Company, Inc., 2121 Sylvan Ave., Toledo, Ohio. Canadian Agent: Canadian Industries, Ltd., Montreal, P. Q.

PLASKON

*** MOLDED COLOR ***

The clean, clear tones of Plaskon molded buttons are uniform and unchanging, because they are solid, permanent color through and through. Their gloss remains bright and sparkling under any service.

Marine moldings

AN outboard motor that goes to sea is doomed to spend its life surrounded by an element hostile to metal: salt water. Makers of this type of marine engine are therefore constantly searching for materials which will resist the corrosive and electrolytic action of brine. Such material must also be strong, light, and add to the appearance of the unit. Aluminum was used until it became hard to obtain.

Evinrude Motors is currently solving this problem by making eleven parts of their outboard models from molded phenolic. Although none of the eleven is in hard mechanical service, they must all be endowed with durability and wear resistance—qualities which phenol-formaldehyde plastics possess in high degree. Redesign of some of the parts was necessary when the change from aluminum to plastics was made, although most of them could be kept to the same dimensions and thickness of section. The high gloss of the new parts made a distinct improvement in the looks of the motor.

The new plastic carburetor control knob (second from top at left of the photograph) demonstrates the legibility of the depressed lettering made possible by the change-over from aluminum to the phenolic material. The die-cast aluminum knob had 0.015 in. raised lettering; that of the phenolic knob is depressed 0.010 in. and wiped in with white enamel, making it much easier to read. The metal insert is molded-in.

Completely redesigned were the steering handle control knob (lower left) and the armature base handle ball (lower center). Previously machined aluminum, the former now presents an enhanced appearance and improved design. The armature base handle, formerly an aluminum forging terminating in a polished ball, now consists of a stamped steel bar with a phenolic ball molded in two halves which are assembled about the end of the control lever to form a rounded terminal.

The gasoline filter cap (upper right), one of the first plastic items to be incorporated in the Evinrude motor, pointed the way to the possibilities of plastics for marine engine parts when it was discovered that its threads did not stick as had those of its aluminum predecessor. Molding the pump deflector (lower right) of phenolic demonstrated the resistance of this material to corrosion. Chemically inert, phenolic resins are impervious to electrolytic action, to acids and to salt water. The pivot bearing bushing (upper left), which fits around the drive housing, is another plastic adaptation.

The largest molded part used in the motor is the Simplex starter housing (center), which was originally of die-cast aluminum. Design changes made in the shift to phenolic include larger fillets, thickening of some ribs, and slightly greater mold relief tapers. The $^{3}/_{32}$-in. wall thickness of the plastic part remains the same.

The company has been experimenting with plastics for additional parts of its outboard motor, and postwar designs of the engine will no doubt incorporate further applications.

Credits—Material: Durez. Molded by Kurz-Kasch, Inc., Eclipse Moulded Products Co., Chicago Molded Products Corp. and Imperial Molded Products Corp. for Evinrude Motors, Div. of Outboard, Marine and Manufacturing Co

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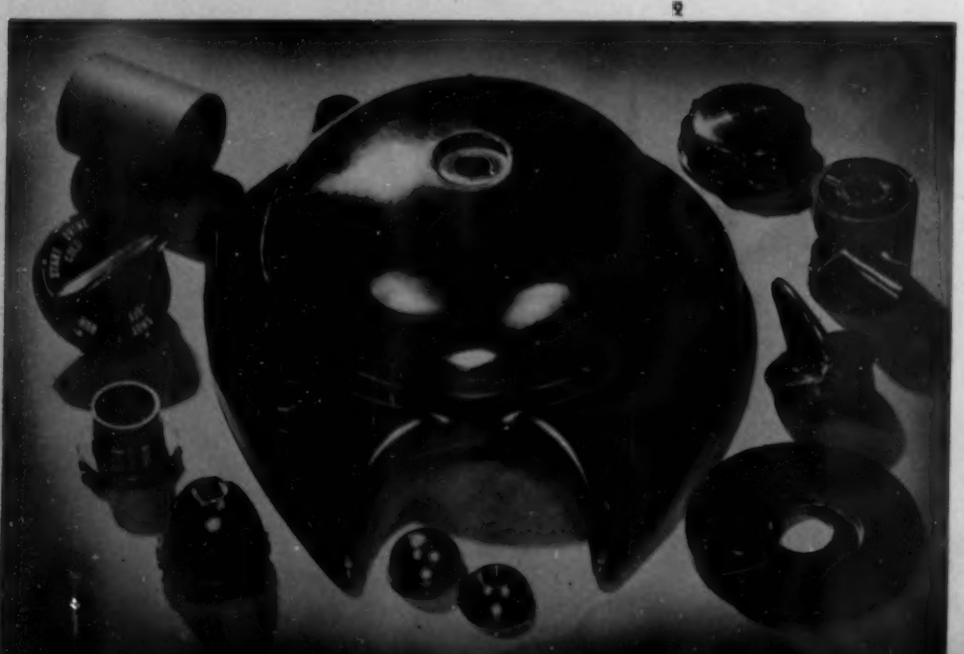
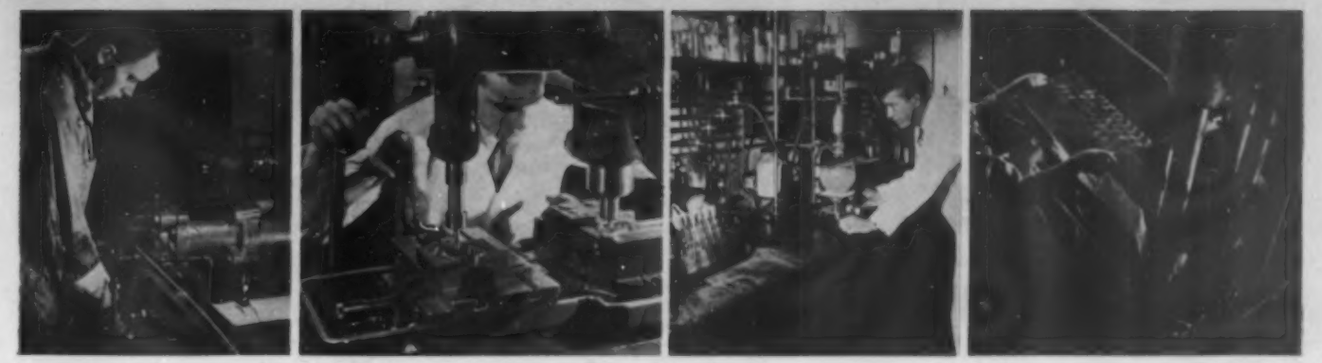


***1**—Smiles induced by two plump fish and a new outboard motor, complete with plastic parts. **2**—Individual parts of the outboard motor designed in molded phenolic. All are corrosion-resistant*



"This Plastic Age"—new motion picture

TO the legend of American industry there has been added a new saga of industrial progress in the last decade. The progress of the plastics industry has taken its place in America with the rise of the automobile, the development of radio, and the triumph of electricity. And, like all legends, it has been accompanied by a mushroom growth of doubt, skepticism, misconception on the one hand; and, on the other, an all-embracing faith in its miraculous powers to accomplish everything that any other known material is incapable of doing. The modern prototype of the "get a horse" contingent stands on the sidelines muttering a doleful obligato, while his more optimistic but equally uninformed brethren hopefully chorus, "Let's use it for everything!"

Today, when more than at any previous time in its history the plastics industry is on the offensive, actively engaged in the vital business of helping to gird America for war, it is of prime importance that the industry—its accomplishments and developments in the past, its functions and contributions to the present all-out war effort, its potentialities for the future—be properly evaluated for those within it as well as for those outside. To the many intelligent efforts of the industry to effect such an understanding of its progress has now been added the third in a series of educational films produced by MODERN PLASTICS magazine, entitled *This Plastic Age*.

This Plastic Age is a document of America at work in an industry which will contribute ultimately to a new America. Like a conducted tour through the industry, the film traces the development of the miracle of plastics, out of the present into the future. It depicts the manner in which the challenge of the present has been caught up and met by the genius and science which combine to make the plastics industry, whose contribution to the present war effort is overshadowed only by its potential contributions to the country and the people following the re-establishment of peace.

It is a story of the genius, skill and resourcefulness of a militant industry in a militant America—of an industry which holds within its span the future of a country which will inevitably forge ahead to greater triumphs of science and industry after peace has been restored.

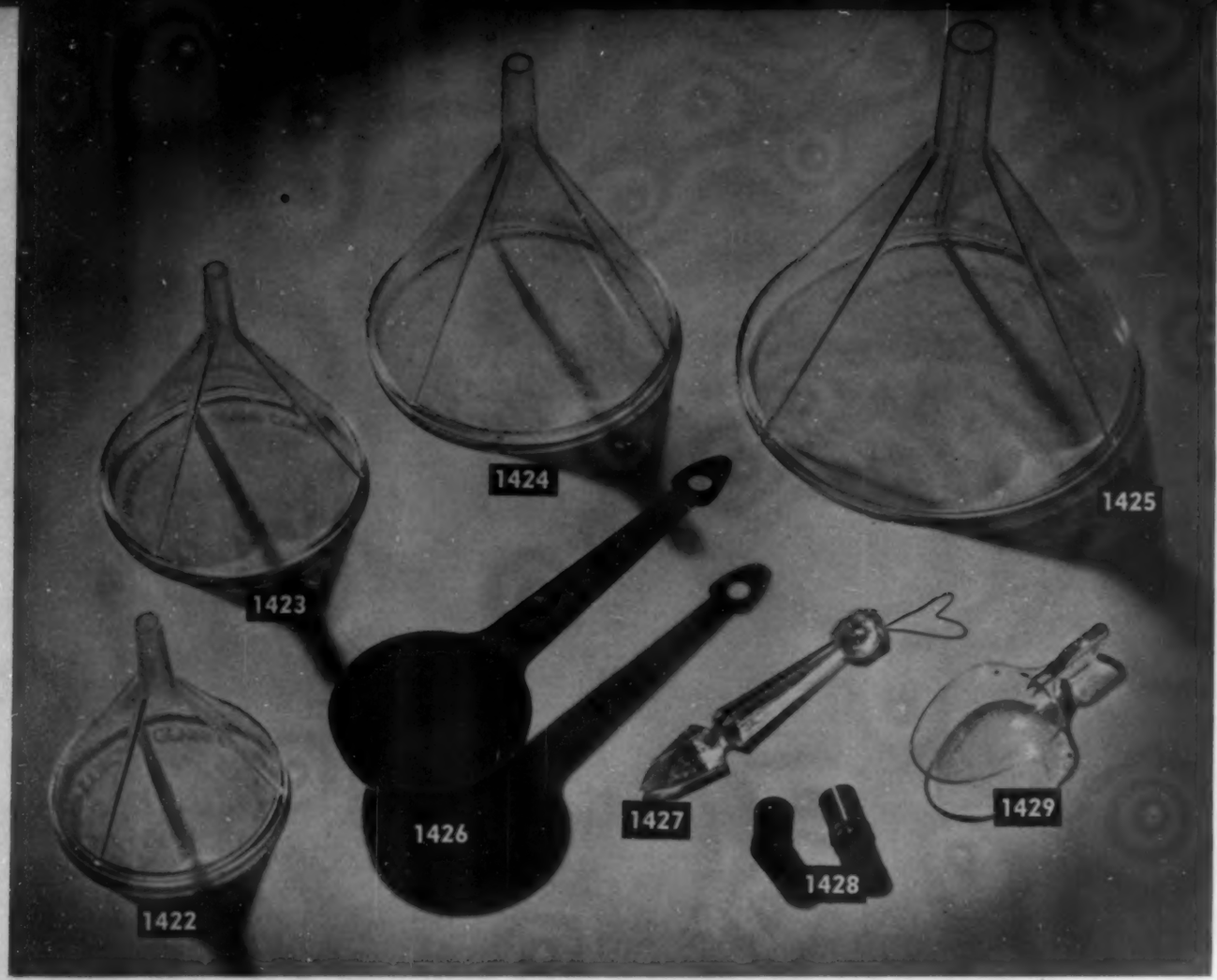
It follows the thread of development from the test tube to the powerful planes that fill our skies in America's supreme war effort; from the laboratory to the streamlined car endowed with the multiple virtues of beauty, strength, endurance and resistance to wear; from raw materials to exquisite fabrics, kitchen utensils, sensitive scientific instruments, ponderous machinery parts, (*Please turn to page 116*)

MODERN PLASTICS COMPETITION POSTPONED FOR THE DURATION

It was just six years ago that the first Modern Plastics Competition was launched with a modest headline in the April 1936 issue of MODERN PLASTICS magazine which read: "Announcing Modern Plastics Competition." That first Modern Plastics Competition was the spontaneous expression of the need of a young and growing industry to establish a common meeting ground for new developments, new ideas, new applications and new concepts. Out of this first Competition, with its three classifications, and its "several hundred entries," grew the Annual Modern Plastics Competition which in 1941, in its sixth edition, had grown to eighteen separate classifications to accommodate the more than 1800 entries representing every phase and aspect of the plastics industry.

As the scope of the industry increased, the expansion was faithfully mirrored in the Competition classifications. To those first three groupings—Style, Industrial and Decorative—there was added year by year a growing roster of additional classifications whose titles bespeak the mature development of the plastics industry's efforts: Architecture, Business and Office Equipment, Major Household Appliances, Lighting, Transport, Communications, Scientific, Musical Instruments, Wearing Apparel. Every phase of American life, every transition of the plastics industry was represented and still the list grew, until finally in 1941 there appeared for the first time a classification called "Military and Defense." With the total energies of the country turning to defense, the plastics industry was ready to share the responsibility of all industry.

Today with America at war, the plastics industry has in a body taken up the challenge of a grim present and enlisted in a body for the duration. And in an industry geared to a war emergency, Competitions, as well as all considerations other than production, are in abeyance. Today, with history being made on the production front as well as on the battle front, the plastics industry is emerging as one of the most significant industrial developments of the era. With the winning of victory and the re-establishment of peace, the Annual Modern Plastics Competition will again be resumed to record and foster the triumphant progress of the plastics industry.



Reprints of all stock mold pages which have been published to date, with a complete index of suppliers, are available to Stock Mold Service subscribers. All molders are invited to send samples from stock molds to appear on this page as space permits

Stock molds

SHEET ONE HUNDRED-NINETEEN

Transparent funnels for fixed oils and aqueous solutions, coffee measuring spoon, medicinal teaspoon, lamp prism and pencil tops are all available from stock molds without mold cost—subject, of course, to current restrictions on raw materials. Address Modern Plastics, Stock Mold Dept., Chanin Bldg., N. Y.

1422. Funnel, 1-oz. capacity. Overall diameter 2 1/4 in.; height 2 5/8 in. 1/8 in. opening at narrow end

1423. Funnel, 2-oz. capacity. Overall diameter 2 3/4 in. Height 3 in. 1/8 in. opening at narrow end

1424. Funnel, 4-oz. capacity. Overall diameter 3 3/8 in. Height 3 3/4 in. 3/16 in. diameter opening at narrow end

1425. Funnel, 8-oz. capacity. Overall diameter 4 5/6 in. Height 4 5/8 in. 3/8 in. opening at narrow end

1426. Coffee measuring spoon in red. 5 3/8 in. overall length. Bowl 1 7/8 in. diameter at top with 1 1/4 in. diameter base. 11/16 in. deep. 1/4 in. opening at end

1427. Decorative "tear drop" or lamp prism, flat at the back, ridged top. Overall length 3 1/4 inches

1428. Pencil caps in black and red. Finely ridged 1/8 in. border. Overall diameter 3/8 in. Overall height 9/16 in. Concentric rings molded in for top decoration

1429. Transparent, short-handled, standard size teaspoon for medicinal dosages. Overall length 5/8 in. Bowl 1 5/8 in. long by 1 3/16 in. at widest part. Material is resistant to alcohol and most medicines

DR. GORDON M. KLINE, Technical Editor

High density plywood

by THOMAS D. PERRY*

METALLURGISTS and engineers in metals have developed methods of heat treating, tempering and alloying metals in order to increase their strength qualities and to improve their durability under adverse conditions of use. The resulting products may be designed to have much higher strength characteristics than the original materials. This improved product, on a tonnage basis, may cost more, but from the standpoint of service, strength or durability may be far more economical. These developments in the metal field have become well established so that engineers and designers can use them intelligently.

In the wood utilization field, the processes of improvement and strength increase have developed far more slowly, and are now just beginning to emerge as a useful branch of plywood technique. The problems of wood improvement are entirely different from those of the metals. Metals are homogeneous, with approximately equal strength in all directions, and they are thermoplastic, i.e., they flow under heat. Wood is strong for its weight, in the direction of the grain, but weak across the grain and splits easily. This strength differential has been largely overcome by the use of standard plywood constructions, in which the alternate layers have opposed grain directions. Thus the lengthwise strength is distributed and utilized to reinforce the widthwise weakness. If the adjacent grain relations of the layers are 30 deg. or 60 deg. instead of 90 deg., the strength is still further distributed. Other variants in plywood construction, such as the cross layering of every fifth or tenth layer, or even laminated wood with all layers parallel, are recognized options in plywood constructions and afford larger ratios of stiffness and tensile strength, if desired.

This distribution of strength in plywood construction adds little to the aggregate strength, except such as may be derived from a slight penetration of the adhesive at the wood surfaces, which functions both as an adhesive and as an additional binder in the surface strata of the wood fibers. Hence the thinner the individual layers, the greater the fiber binding effect of the adhesive. Normal plywood, however, has found many fields of utilization where it is a distinct improvement over solid or unlaminated wood. With the advent of thermosetting resin adhesives, the application of heat increased this penetration into the wood, and the resin adhesives otherwise had much better durability than the earlier conventional glues.

Wood compression problems

It is well known that wood compresses more when heated than when cold, and that wet wood compresses more easily than dry wood. This ease of compression in wet wood may result either from a higher moisture content of the solid wood or, in plywood constructions, from the flow of a resin adhesive during its thermosetting cycle. Any compression of wood that is to be reasonably permanent in dimension will result in more wood fiber per square inch of section; consequently, such compressed wood will be much stronger per square inch than uncompressed wood. Large or thick blocks of solid wood are difficult to compress without shattering or destroying the cohesion of the fibers, and if not so weakened, the compression usually springs back. The complete and uniform impregnation of wood blocks of substantial size is difficult and usually uneconomical. Hence the successful compression technique is best carried out in thin layers of veneer, viz., in plywood or laminated wood constructions. The compression mentioned above relates to reductions in thickness, and not to endwise compression, which presents entirely different problems.

Wood improvement by densification

This outline of the problem indicates that the best compression or densification technique to improve wood is most likely to be found in the plywood field. The last two or three years have witnessed considerable progress toward the solution of this wood "improvement" or high density problem. The literature bearing on the subject is growing, and the more important references are cited in the bibliography at the end of this article. In the main these writers have emphasized individual processes to attain certain specialized ends and each of their steps is a definite contribution to the total knowledge on the subject. However, there is a regrettable absence of any comprehensive endeavor to evaluate and compare the relative merits of the various methods that have been described.

It would be a presumption to attempt more than a preliminary analysis of the processes that now appear to be the most promising. The current development work at Government and private laboratories may easily result in substantial revision at any time. However, enough is known and established to give a glimpse of what may be expected.

Progress in wood improvement is occurring along two main lines, i.e., that of producing limited resin impregnation by the use of phenolic resin films interlaid between thin veneers, and that of immersing veneers in phenolic resin solutions for more complete impregnation.

High density with resin films

Considering first the use of resin films: it has been determined[13] that significant penetration of resins begins in veneer thicknesses of $^1/_{30}$ inch. Thicker veneers do not permit the addition of sufficient binder to provide reasonably permanent

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TABLE I.—RESIN CONTENT RATIOS FOR TEGO-BONDED PLYWOOD

Veneer weights at 10% moisture content; Tego Film at 11 lbs. per 1,000 sq. ft., adjusted for solid resin content.

Wood species	*Veneer thickness, in.*	*Weight of veneer, oz./sq. ft.*	*Weight of resin, oz./sq. ft.*	*Resin content, percent*
Birch	1/8	6.56	.117	2
	1/16	3.28	.117	3.5
	1/24	2.19	.117	5.5
	1/30	1.76	.117	6.5
	1/40	1.31	.117	9
	1/.3	1.09	.117	11
	1/60	.87	.117	13.5
Poplar	1/8	4.43	.117	2.5
	1/16	2.22	.117	5
	1/24	1.47	.117	8
	1/30	1.19	.117	10
	1/40	.79	.117	15
	1/60	.58	.117	20

dimension under compression, nor to supply enough penetration for the supplementary fiber cohesion required. When veneers thinner than 1/30 in. are used, cost factors and difficulties of handling are somewhat increased. The extent of resin ratios attainable under this process, based on two principal species, is shown in Table I.

The effect of higher specific pressures on the tensile strength of plywood made of 1/48-in. birch veneer, as an example, is shown in Table II; enough layers of veneer were used to total one full inch after compression.[13]

It is to be noted that, in this construction, the gains are less between 1000 and 1500 lb. than between 500 and 1000 lb. Other investigations have shown that when using 1/30-in. birch veneer, involving a lower resin to wood ratio than with 1/48-in. veneer, the gains are more evenly distributed between 500 and 1500 lb. specific pressure.

This method of resin reinforcement, by the use of a film, is by far the simplest and most cleanly.[13] The ratio of resin to wood can be accurately controlled by the thickness of the veneer. The operating cycle is short, and consists of dimensioning and interlaying the film, and curing the resin under heat on schedules of approximately 15 min. per 1/4 in. of final thickness.

High density with liquid impregnation

In the case of impregnation with a liquid resin, the process becomes somewhat more complex and the cycle of operations is considerably longer. Sheets of veneer are soaked in a phenolic resin solution, usually between 30 and 40 percent solids in water. The time required for a practical degree of impregnation depends on the thickness of the veneer, its cellular structure (species or growth) and the affinity existing between the chemical constituents of the particular wood and resin that are involved. Three methods of resin deposit have been used: continuous soaking of the veneer until the desired resin ratio is obtained; immersion of the veneer under vacuum and pressure to shorten the time needed for the resin content desired; and stacking together (solid) the partially soaked sheets for further dispersion or diffusion of the resin into the sub-surface portions of the veneer.

It should be kept in mind that normal wood structure consists mainly of cells which have more or less hollow cavities, surrounded by somewhat spongy or porous walls. Shrinkage and swelling in wood occur principally because of moisture removal from, or moisture absorption into, this porous cell wall, causing contraction or expansion in the size of the individual cell. Moisture content under 30 percent resides mostly in these cell walls, and practically all shrinking and swelling of wood happens in this 0 to 30 percent moisture content zone. Above 30 percent water content, little dimensional change in the wood is to be noted.

It thus becomes evident that filling the cell cavity with an impregnant will not be so effective in reducing shrinkage and swelling as will an impregnant that permeates the cell wall. While filling the cell cavity will add weight and increase density, it is less likely to retard shrinking and swelling materially. Dimensional stability and fixed weight may be important in some uses of high density plywood, but ability to expand slightly under moisture may be equally useful in other applications.

Adequate penetration into these porous cell walls appears to be a function of the molecular size of the resin, as well as of the chemical affinity that may exist between the resin and the fibrous wood structure. Hence resins of small molecular size appear to be preferable for this impregnation process. The Forest Products Laboratory publications, [10, 15] by Drs. Stamm and Seborg, were the first to present an adequate outline of this method in this country.

After the veneers have been properly impregnated by any one of the three processes, it is necessary to evaporate the surplus resin solvent (usually water) down to a point where it will not produce steam pockets and blisters when the resin is cured in a hot press. This is usually a point at which the residual moisture content in the impregnated and dried veneer is from 10 to 12 percent. This drying must be done at temperatures that will not cure the resin or reduce its later adhesive qualities. The hot press cure of these impregnated veneers, assembled into plywood, requires proper protective measures to prevent unwanted adhesion to the press platens or metal cauls. This adhesion between veneer and platens does not occur when using a resin adhesive film. This absence of surface impregnation, as in the use of a film, is a distinct advantage in such subsequent gluing operations as may be required.

It is found desirable to cool both film and liquid types of high density plywood before releasing pressure.[13] Otherwise a "washboard" surface may occur, due to certain volatile content. However, the strength losses are slight if such cooling is not practiced.

Another factor in the use of a liquid resin impregnant is that compression occurs at lower pressures than when using resin films.[15] A specific pressure of the order of 500 lb. with

TABLE II.—EFFECT OF PRESSURE ON TENSILE STRENGTH OF PLYWOOD

Tego-bonded 1/48-in. birch with alternate cross layers and estimated resin content of 11 percent.

Specific pressure, lb.	*Layers of veneer*	*Specific gravity*	*Tensile strength lb./sq. in.*
200	57	.77	12,550
500	69	1.05	19,160
1000	81	1.30	25,740
1500	85	1.35	26,760
	INCREASE AT HIGHER PRESSURES		
	Percent	*Percent*	*Percent*
200	..	..	..
500	21	36	53
1000	42	69	105
1500	49	77	114

liquid resin impregnants will give approximately the same degree of compression as 1200 to 1500 lb. with films.

The ratio of resin to wood, when using a liquid impregnant, may be 50 percent by weight in the compressed product, when compared with an equal amount of uncompressed and untreated wood, of the volume that was originally used in the compressed product. It is believed that resin/wood ratios of over 30 percent add little to the desirable characteristics of the compressed product.

It might be noted in passing that veneers thus impregnated with a liquid resin may be cured under heat but without pressure.[15] This hardened but uncompressed veneer can be combined into plywood with resin adhesives and additional layers of untreated veneers. This method produces a high density surface with a low density interior, but requires a two-stage cure. Another method is to combine impregnated outer veneer with unimpregnated inner veneer, using Tego Film as an adhesive for the resulting plywood. Under proper temperatures with a pressure of around 300 lb., the outer veneer will be cured and densified, while the density of the inner veneer will be altered little and the whole will be bonded into plywood at one operation. This hard exterior with a lightweight interior produces a type of plywood which has definite advantages in certain applications. This may not be strictly high density plywood, but it is an interesting related product.

Product comparison

It has been pointed out that high density plywood made by the use of resin films is simpler and quicker to make, and that the ratio of resin to wood is easily controlled, but is not likely to exceed 12 percent. The resulting product can be described as plywood reinforced with plastic; and wood characteristics, improved over normal wood, can be expected to predominate.

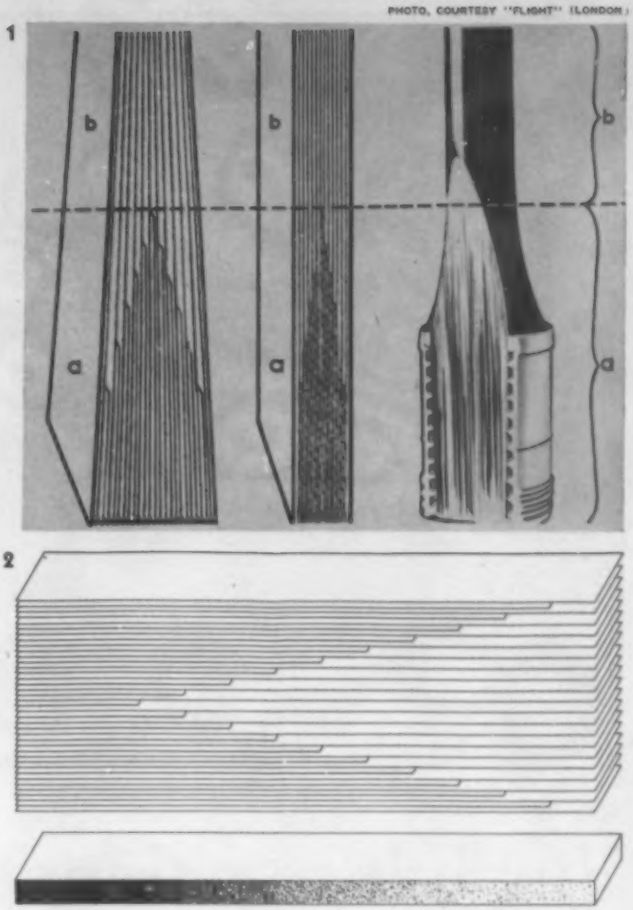
On the other hand, the high density product made with liquid resin impregnants will have a ratio of the order of 25 to 35 percent. Its manufacture is more complex and time consuming, and requires more careful regulation for various resin ratios. The product from this process is best described as plastic reinforced with wood, and the qualities of the plastic will be dominant.

Strictly speaking, these do not lie in the same field of utilization, and can be considered competitive only in the range within which they approach each other's characteristics. The physical qualities of both can be varied within broad limits, and available experience does not yet provide comparisons of cost.

Effect of moisture

The phenomenon of moisture absorption into normal solid, dry wood is well known, and consequent swelling (dimensional increase) may average as high as 10 to 15 percent, in width or thickness. Endwise swelling is negligible. In the case of plywood made at normal pressures, swelling will occur chiefly in thickness, due to the restraining effects of the adjacent bonded layers of endwise and crosswise grain. On the other hand, high density plywood is far more resistant to moisture absorption, since the degree of resin impregnation substantially retards the subsequent penetration of moisture into the cell walls. There is a conspicuous difference between uncompressed and compressed wood in its capacity to expand under moisture. Compressed wood tends to return part way to its original uncompressed dimension, and is restrained by the resin binder. On redrying, it will return part way to its compressed dimension, but not all the way. The evidence indicates that reduction in dimensional changes depends not on the density alone, but rather on the proper impregnation of the porous cell walls. Obviously in the case of plywood constructions this dimensional change is chiefly in thickness, the direction in which the compression takes place.

PHOTO, COURTESY "FLIGHT" (LONDON)



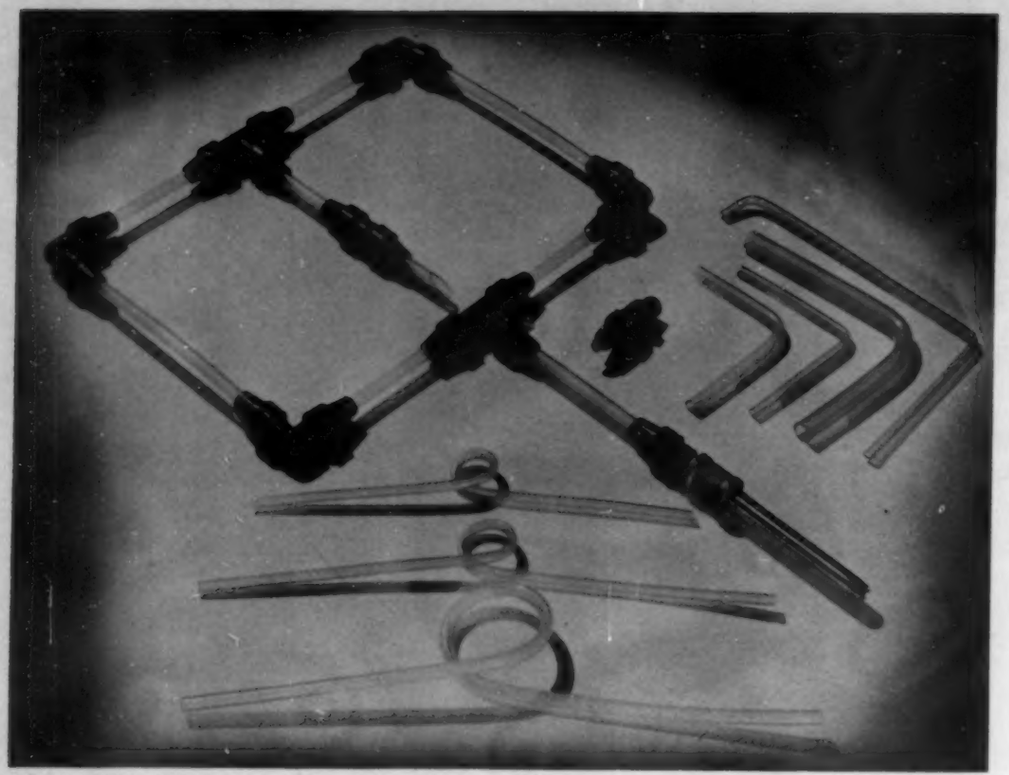
1—Variable density propeller construction showing extra laminations before (left) and after compression (center) which results in higher density and greater strength near the hub than at the tip. Right—root of a propeller blade. Sections (a) are superpressed plywood portion, (b) normal portion. 2—Differential density layer for propeller. Assembly before hot pressing is shown above. Layer after it was pressed to uniform thickness is below

While available data on the dimensional effect of moisture on high density plywood are quite limited, it seems well established that it is distinctly less than in normal plywood. Where exposure is to be expected, adequate protective coatings should be applied and maintained, as is equally true of normal plywood.

It should be noted that there are many uses of both types of plywood where expansion under the influence of moisture is a distinct advantage, as in boats, marine constructions, barrels and the like. On the other hand, uneven moisture absorption in such a construction as an airplane propeller may seriously impair the proper balance. Hence proper surface protection is often imperative.

Variable density plywood

The Schwarz process of making airplane propellers, i.e., scarfing $^1/_8$-in. layers of high den- (*Please turn to page 110*)



PHOTOS, COURTESY DOW CHEMICAL CO.

1

Chemical-resistant resinous fittings and tubing are easily fabricated, long wearing. The fittings at top are injection molded from vinylidene chloride resin. Fabricated shapes can be made from tubing of this material, shown at bottom

Vinylidene chloride resin tubing

by C. B. BRANCH and D. L. GIBB*

IT has been said that the Machine Age began with the invention of the wheel, but certainly the wheel is little more essential to the whole structure of modern life than is the tube. Man depends on some form of hollow conductor for the delivery of food and drink, for heat, light, transportation and sanitation. Destroy tubing and man would be grounded, cities would be deserted, industries would perish, transportation would revert to the horse and buggy and the wheel could fulfill only its most primitive functions. Obvious as this may be when brought to mind, it is nevertheless true that these facts are seldom, if ever, considered by most of us.

It is not strange, then, that a reduction in the amount of tubing available for civilian use should present serious problems to innumerable persons and industries; nor that a new plastic tubing capable of replacing metal tubing in many applications should be a matter of great general interest. Such a tubing is made of Saran,[1] a thermoplastic resin formed by the copolymerization of vinylidene and vinyl chlorides. The basic polymer is tasteless, odorless, nontoxic and nonflammable.

This resinous tubing is being produced commercially throughout the country by a number of licensed fabricators who are in a position to give prompt attention to essential civilian or war requirements. They extrude the resin with a specially designed tuber in which all metal surfaces coming in contact with the hot polymer are made of proper metals. The tubing is produced in seamless, continuous lengths, and is at present available in sizes from $^1/_8$ to $^3/_8$ in. in diameter, and wall thicknesses of .031 to .062 inch. Present trends point to fabrication of tubing up to $^3/_4$ in. in diameter in the near future. Certain of the physical properties of this resinous tubing are listed in Table I.

Saran is particularly suited for tubing because of its relatively sharp melting point and resultant retention of physical properties within the service temperature range. Another advantage of this tubing is its comparatively high bursting pressure. Some individual values on tubing of $^1/_4$ in. outside diameter by .037 in. wall thickness at 25 deg. C. (77 deg. F.) have been as great as 2250 lb. per sq. inch. The working fiber stress for various tubing sizes is illustrated by Fig. 2. This curve shows the change in recommended working fiber stress with temperature variations. To use this curve in determining working bursting pressures for tubing of specific sizes and wall thicknesses, the following formula should be employed:

$$W.F.S. = W.P. \times \frac{OD^2 + ID^2}{OD^2 - ID^2}$$

where W.F.S. = working fiber stress
W.P. = working pressure
OD = outside diameter
ID = inside diameter

For safety, the bursting pressure has been reduced by a factor of 5 in order to obtain the recommended working pressure. This, combined with the fact that the bursting pressures and fiber stresses employed in determining the above

* Dow Chemical Company.
[1] Trade Mark Reg. U. S. Pat. Off.

curve are based on the minimum figures of large numbers of production batches, makes the figures obtained from this formula very conservative.

A representative set of curves for tubing of 1/4-in. outside diameter is shown in Fig. 3. These curves indicate not only the change in working pressure with temperature, but with wall thickness as well. It will be noted that when the temperature is decreased from 100 deg. C. to 25 deg. C., the working pressure is approximately tripled. In the same way, when the temperature is decreased from 25 deg. C. (77 deg. F.) to 0 deg. C. (32 deg. F.), the working pressure is approximately doubled. At the same time, this change in bursting pressure is accompanied by a corresponding reduction in impact strength.

Table II shows the changes in bursting pressure with changes in cross sectional area. (*Please turn to next page*)

TABLE I.—PROPERTIES OF SARAN TUBING

I. Mechanical properties
- A. Bursting strength—see Table II
- B. Ultimate elongation—15–25 percent
- C. Impact strength, 1/2 × 1/2 in. notched bar, Izod—2–8 ft. lbs. per in. of notch
- D. Hardness (Rockwell Superficial 15Y)—71
- E. Hardness (Rockwell M)—38
- F. Tensile strength, ultimate—4000–6000 lb. per sq. in.
- G. Compression strength, yield point—7500–8500 lb. per sq. in.
- H. Modulus of elasticity in tension × 10^5 range—0.7–2.0 lb. per sq. in.
- I. Flexural strength—15,000–17,000 lb. per sq. in.

II. Thermal properties
- A. Thermal conductivity—0.00022 cal./sec./cm.²/deg. C./cm.
- B. Specific heat—0.32 cal./deg. C./gm.
- C. Resistance to heat (continuous)—satisfactory up to 175 deg. F (80 deg. C.)
- D. Heat distortion temperature—150–180 deg. F. (66–82 deg. C.)
- E. Tendency to cold flow—slight
- F. Coefficient of thermal expansion—15.8 × 10^{-5}/deg. C.
- G. Melting point—310–325 deg. F. (155–163 deg. C.)
- H. Extrusion temperature—up to 375 deg. F. (190 deg. C.)
- I. Injection molding temperature—300–400 deg. F. (149–204 deg. C.)
- J. Mold shrinkage, injection—0.008–0.012 in. per in.

III. Electrical properties
- A. Volume resistivity, ohm/cm. at 50 percent relative humidity, 25 deg. C. (77 deg. F.)—10^{14}–10^{16}
- B. Breakdown voltage, 60 cycles, instantaneous
  3000 volts per mil at 1 mil thickness
  1500 volts per mil at 20 mils thickness
  500 volts per mil at 125 mils thickness
- C. Power factor, 60, 10^3, 10^6 cycles—0.03–0.15
- D. Dielectric constant, 60, 10^3, 10^6 cycles—2.5–5.0

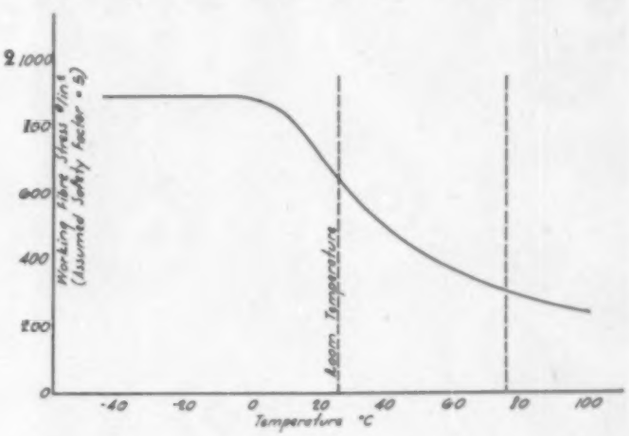
IV. Optical properties
- A. Refractive index n_D = 1.61
- B. Clarity—translucent to opaque
- C. Color possibilities—extensive

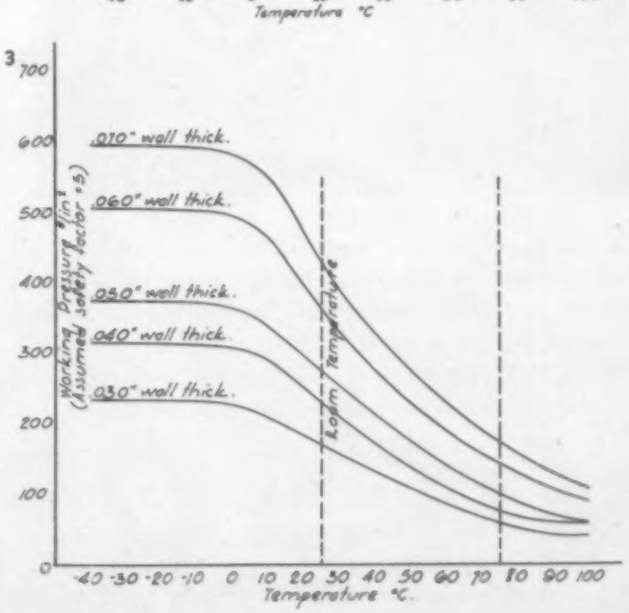
V. General properties
- A. Specific gravity—1.68–1.75
- B. Specific volume—15.8–16.6 cu. in. per lb.
- C. Water absorption, 24 hr. at 25 deg. C. (77 deg. F.)—0.00 percent
  Water absorption, 168 hr. at 75 deg. C. (167 deg. F.)—0.5 percent
- D. Water permeability—negligible
- E. Corrosion resistance—excellent
- F. Effect of metal inserts—none
- G. Machining qualities—good
- H. Burning rate—self-extinguishing
- I. Fatigue resistance—excellent
- J. Effect of sunlight—darkens slightly

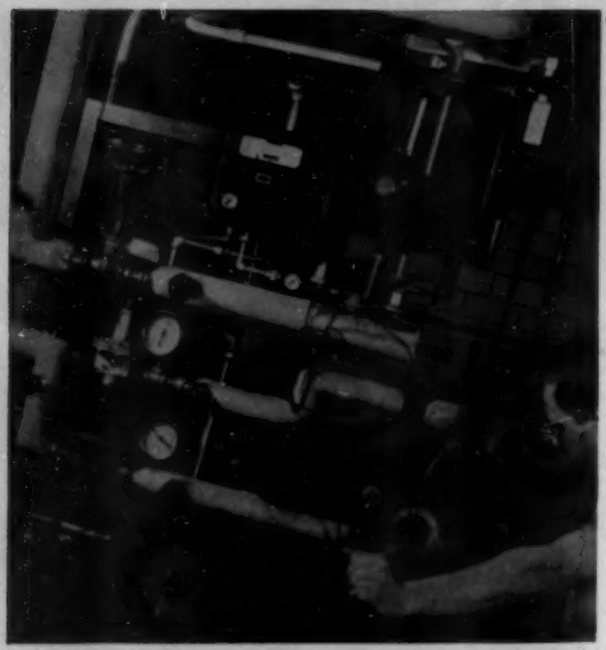
TABLE II.—BURSTING PRESSURES OF SARAN TUBING AT 25 DEG. C. (77 DEG. F.)

Outside diameter, in.	*Wall thickness, in.*	*Cross-sectional area, sq. in.*	*Bursting pressure, lb./sq. in.*	*Working pressure safety factor = 5, lb./sq. in.*
1/8	.031	.0092	1900	380
3/16	.031	.0152	1250	250
1/4	.031	.0213	900	180
1/4	.045	.0290	1350	270
1/4	.062	.0366	1900	380
5/16	.031	.0274	700	120
5/16	.062	.0488	1700	340
3/8	.031	.0335	575	115
3/8	.062	.0610	1250	250

***2**—Chart shows recommended working stresses vs. temperature, Saran tubing B-115. **3**—Working pressures vs. temperature, for same tubing, 1/4 in. outside diameter*







4—Extrusion machine showing control bank for the vinylidene chloride resin tubing which is extruded under controlled temperature conditions and is then passed through a water bath in a trough for cooling. 5—View of take-off and coiling mechanism employed

It will be noted that the operating pressures for most tubing installations are usually well within the listed pressure limits.

One of the outstanding characteristics of Saran is its resistance to chemicals and solvents at room temperature. This fact is illustrated strikingly by the data in Table III.

TABLE III.—RESISTANCE OF SARAN AT ROOM TEMPERATURE TO THREE MONTHS OF CONTINUOUS EXPOSURE TO CHEMICALS[1]

Reagent	*Stability rating*
98 percent (conc.) sulfuric acid	Good
60 percent sulfuric acid	Excellent
30 percent sulfuric acid	Excellent
10 percent sulfuric acid	Excellent
35 percent (conc.) hydrochloric acid	Excellent
10 percent hydrochloric acid	Excellent
65 percent (conc.) nitric acid	Excellent
10 percent nitric acid	Excellent
Glacial acetic acid	Excellent
10 percent acetic acid	Excellent
5 percent sulfurous acid	Excellent
Conc. oleic acid	Excellent
50 percent sodium hydroxide	Fair
10 percent sodium hydroxide	Good
28 percent ammonia	Unsuitable
10 percent ammonia	Poor
Ethyl alcohol	Excellent
Ethyl acetate	Fair
Acetone	Fair
Methyl iso-butyl ketone	Fair
Carbon tetrachloride	Good
Ethylene dichloride	Poor
Diethyl ether	Poor
Dioxane	Unsuitable
Benzene	Fair
o-Dichlorobenzene	Poor
Ethyl gasoline	Excellent
Turpentine	Excellent
Butyraldehyde	Excellent
Triethanolamine	Excellent
Lubricating oil	Excellent
Linseed oil	Excellent
Bromine water	Unsuitable
Chlorine water	Unsuitable
Bleaching solution	Excellent
10 percent duponol	Excellent
10 percent zinc hydrosulfite	Excellent
15 percent calcium chloride	Excellent
15 percent ferrous sulfate	Good
Water	Excellent
Air	Excellent

[1] These stability ratings are made up on the basis of observations of change appearance, weight, dimensions, tensile strength and hardness.

The table shows the wide range of chemical resistance and consequent versatility of application of this resinous tubing where chemical resistance is a problem. Even in cases where the tubing is attacked by corrosive agents, it will frequently be found to have greater service life than other materials used commercially. The most striking feature of this chemical resistance is that many combinations of corrosive agents and solvents, each of which formerly presented individual problems in handling, may now be satisfactorily transferred together through this chemically resistant plastic. Generally, chemical resistance decreases with increasing temperature.

In order to illustrate the advantages as well as the limitations of this new tube, it is compared with copper in Table IV. From this table, it will be apparent that Saran should be chosen where chemical resistance, flexibility and fatigue strength are the more important factors; copper where stiffness and resistance to high temperatures are required. There are, of course, many applications, such as transfer of air or water, in which the two materials should be equally

satisfactory; and other factors, such as ease of fabrication and availability, will regulate the choice.

Saran tubing may be joined by some of the same types of connectors commonly employed with metal tubing. These include flared, compression, welded and flanged fittings. For the smaller-sized tubings which are now available, flared types are very satisfactory. The flaring can be accomplished at room temperature with compression-type flaring tools, or by spinning. If the tubing is cold, it is recommended that the end of the tubing and the flaring tool be heated to room temperature before flaring is attempted. Any necessary trimming may be done with a sharp cutting tool or a file.

The use of a complete resinous system is now possible through the use of flare-type Saran fittings made by injection molding. These fittings are slight modifications of the standard S.A.E. fitting designs, and have the advantage of providing a plastic seal between the tubing and the fitting. This combination eliminates any possible leakage due to unequal thermal expansion of the resinous tubing with metal fittings, provides for a uniform chemical-resistant system and leads to the complete elimination of strategic metals. At the present time, couplings and adaptors as well as elbows and tees are available from molders equipped to injection mold this resin.

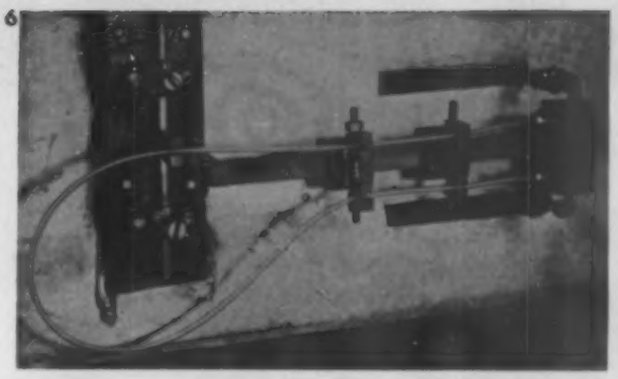
In bending this resinous tubing at room temperature, the tendency to kink decreases with increasing wall thickness. At a wall thickness equal to 20 percent or more of the diameter of the tubing, it is extremely difficult to kink or collapse. Even in those cases where actual kinking or total collapse occurs, the bursting pressure is reduced no more than 20 percent. Such fabrication as bending or forming to permanent desired shapes is easily accomplished. The tubing is formed at room temperature to the required shape plus allowance for 20 to 30 percent springback. It is then heated to approximately 100 deg. C. (212 deg. F.) for 15 to 30 sec. and on cooling will be set to shape. The heating in this procedure may be easily and conveniently obtained (*Please turn to page 110*)

TABLE IV.—COMPARATIVE SERVICE CHARACTERISTICS OF SARAN AND COPPER TUBING

Service conditions[1]	*Saran*	*Copper*
Acids	Excellent	Fair
Caustic	Good	Good
Bleaching agents	Excellent	Fair
Salts	Excellent	Fair
Ammonia	Poor	Fair
Solvents	Good[2]	Good[2]
Water	Excellent	Excellent
Air	Excellent	Excellent[4]
Oil	O.K.	O.K.
Low temperature	Becomes stiff and brittle	O.K.
70 to 170 deg. F.	Flexible	Unchanged
High temperature	Not recommended over 170 deg. F.	Unchanged
Flexing	Excellent	Limited
Freezing cycles	Excellent	Limited
Closed system		
Vibration fatigue	Excellent	Limited
Heat conductivity	Slow	Rapid
Fluid flow	Equal to copper	
Physical state	Flexible	Stiff
Clarity	Semi-transparent	Opaque

[1] Chemical resistance based on 3 mos. tests at room temperature.
[2] Not recommended for certain high-oxygen-bearing oxides and some chlorinated aromatic hydrocarbons.
[3] Chlorinated hydrocarbons subject to hydrolysis may be corrosive.
[4] Corrosive gases may deteriorate.

6



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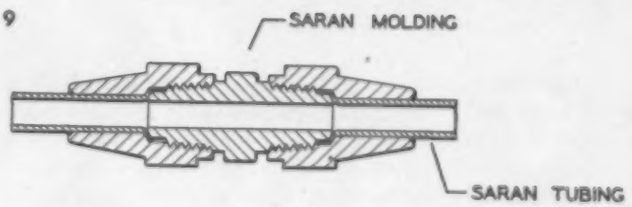


6—Fatigue testing machine for testing the tubing under pressure. Strains are applied at several points along the length. **7**—*This test indicates low heat loss of fluid passing through tubing; temperature of water was 82 deg. C. (180 deg. F.) while temperature on outside of tubing was only 62 deg. C. (144 deg. F.).* **8**—*To flare tubing, it is first squared, then pressure is applied with equipment shown.* **9**—*Diagram shows assembly of injection molded plastic fitting, flare type*

Diffusion of light by plastics*

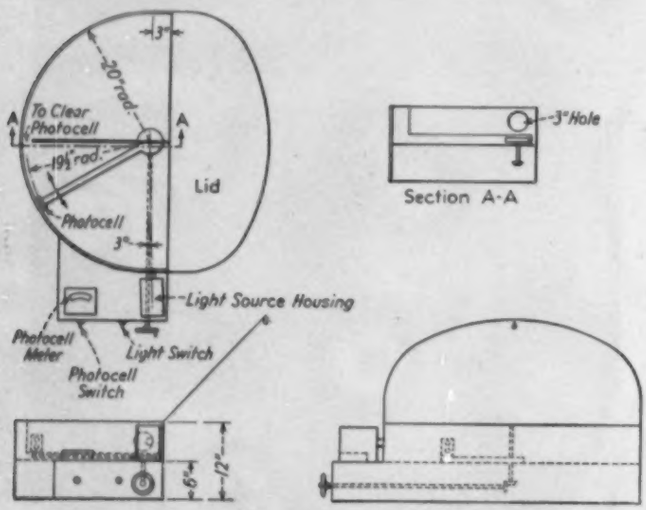
Scope

1. (*a*) This method of test is designed to differentiate the relative ability of plastics to diffuse light and is applicable to materials that scatter incident light to an appreciable extent (diffusion). It is not successfully applicable to the measurement of low ranges of scattering (haze) which are associated with slight departures from optical clarity.

(*b*) An instrument and procedure are described for measuring the reflective and transmissive diffusion of a beam of light by a flat test specimen of the plastic, the face of which is essentially normal to the axis of the light beam, with numerical means for rating the scattering or diffusion in terms of a theoretically perfect light-scattering surface or medium.

Apparatus

2. (*a*) The apparatus shall consist of a goniophotometer, the axes of the active elements of which operate in a horizontal plane that passes through the center of the test specimen. The active elements shall consist of a light source and optical system so oriented as to illuminate the face of the test specimen at its center, a specimen holder which locates the test specimen normally to the axis of the light beam (except as modified by Paragraph (*b*)), a photosensitive receptor fixed to a radius arm which has the vertical axis of the face of the specimen as its center of rotation, a galvanometer for indicating the current flow in the receptor circuit, and an enclosure or other means for excluding extraneous light. These units shall be combined into one instrument in accordance with the requirements prescribed in Paragraphs (*b*) to (*g*):



1—*Dows-Baumgartner double quadrant reflectometer*

(*b*) *Angle of illumination of face of specimen.* The axis of the light beam shall meet the center of the face of the specimen normally, except in the horizontal plane, where it shall be displaced 3 deg. in a counterclockwise direction. This angle allows the receptor element to intercept the center of any specularly reflected component from the specimen, without interfering with the beam leaving the source.

(*c*) *Angular spread of light beam.* The light beam shall be suitably controlled so that its divergence does not exceed 6 deg.

(*d*) *Characteristics of light source and receptor.* The light source shall be an incandescent tungsten filament operating at a temperature between 2800 and 3000 deg. Kelvin or any other source that approximates closely the color temperature of a tungsten filament at the above temperature. The receptor shall have a spectral sensitivity proportional to the luminosity function of the standard I.C.I. observer. Other equivalent source-receptor combinations may be used.

NOTE 1. A T-8, 100-w. projection lamp, operating at its rated voltage, combined with a Photox barrier-layer photocell approximates the specified source-receptor combination. Any other combination that will give the same results as the standard is also considered equivalent.

(*e*) *Receptor unit.* The receptor unit shall consist of a movable arm carrying at its outer end the photocell held vertically facing the center. The movable arm shall be of sufficient length so that the photocell may just intercept the center of any specularly reflected component without interfering with the beam leaving the source. The photocell surface shall be covered by a mask containing a vertical slot that subtends 2 deg. at the center of rotation. The receptor unit shall be rotatable about the specimen through two quadrants from an angle of 3 deg. clockwise from normal to the face of the specimen (center of specularly reflected beam) through 174 deg., when the cell will be diametrically opposite the light source.

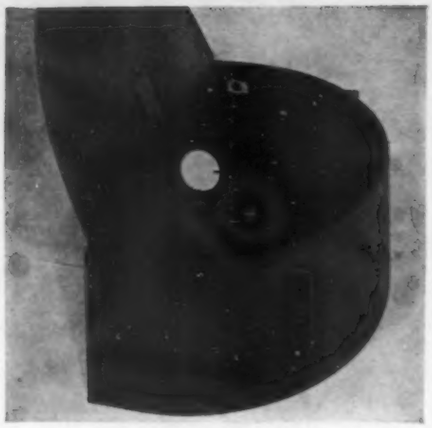
NOTE 2: *Warning.* At no time should the photocell be exposed to excessive light intensity. For barrier-layer cells, a safe maximum should be maintained by limiting the current output to 100 microamperes per square inch of exposed photosensitive surface. This limit may be observed by covering the cell opening with a neutral filter when necessary, which should then remain in place for the complete test (determination of reflective or transmissive diffusion, or both). A neutral gray photographic negative is convenient.

(*f*) *Instrument enclosure and baffling.* The instrument may be contained in its own light-tight enclosure or may be operated in a darkened room with black walls, similar to a photographic darkroom. In the latter case the operator shall wear dark clothing, or stand behind the photocell, or both. The interior of any enclosure and all included instrument parts shall be painted a flat optical black.

While making measurements of diffusion by transmission it is necessary to shield the photocell from scattered light originating in the first, or reflection quadrant by a baffle, not more than $1/16$ in. in thickness and of suitable height, separating the two quadrants. This baffle shall be of such a length that the photocell just clears the outside end, and may be raised off the instrument base to a sufficient height to allow the receptor arm to pass underneath. Both of these openings shall be covered by a loose flap of black opaque cloth or felt.

At the point where the baffle passes over the center of rotation of the receptor arm, a circular hole shall be cut through, against the back of which the face of the specimen shall be

* This tentative method of test for diffusion of light by plastics, A.S.T.M. designation D 636–41 T, is published here by permission of the American Society for Testing Materials.



2—*Interior view of Dows-Baumgartner reflectometer*

placed. The diameter of the hole shall be 2 in. greater than that of the centered light beam.

(*g*) *Galvanometer.* A galvanometer of suitable sensitivity shall be employed in conjunction with the photocell for indicating the magnitude of current flow. The receptor-galvanometer circuit shall be calibrated to obtain a relationship between light incident on the sensitive surface and the corresponding current generated.

NOTE 3. With a barrier-layer cell, a suitable galvanometer is one having a sensitivity of about 0.05 microampere per millimeter and a period of about 2 sec. This may be shunted by a resistance to reduce its sensitivity when measuring highly reflective or transmissive materials. If a galvanometer of 300 ohms or less internal resistance is employed with the barrier-layer type cell, an essentially linear response is obtained between light flux and current. A calibration should be made in any case, however, with and without any shunt that may be used.

NOTE 4. Figure 1 shows an instrument devised by Dows and Baumgartner,[1] which has been modified to satisfy the requirements prescribed in Section 2. It is a double-quadrant goniophotometer embodying a light source containing a T-8, 100-w. projection lamp, a photocell on a radius arm which is rotated by means of a geared shafting brought out to the front panel, toggle switches, and a galvanometer. The instrument is enclosed in a sheet metal body with an optical black interior. Figure 2 is a photographic view of the interior of the instrument.

Test specimens

3. (*a*) The test specimens shall be prepared in the customary manner peculiar to the physical properties of the plastic to be tested (by compression molding, laminating, injection molding, casting, etc.).

(*b*) The surfaces of the test specimens shall be essentially flat for purposes of measurement, except that, if the surface is configurated, the envelope of such configurations shall be flat. If diffusion by transmission is to be measured, the second surface, or envelope thereof, shall be parallel to the first.

(*c*) The thickness of the test specimen shall be 0.050 ± 0.005 in. for comparison purposes. If the surface is configurated, this restriction shall not hold but the structure and depth of the configurations shall be noted. Other thicknesses may be employed, but only when necessary.

(*d*) At least ten units of any configurated design shall be capable of location within the area of the beam of incident light.

(*e*) The test specimen shall be sufficiently large to cover completely the specimen hole of the instrument.

[1] Dows and Baumgartner, "Two Photovoltaic Cell Photometers for Measurement of Light Distribution," Transactions, Illum. Engr. Soc., *30*, 6 (1935).

Procedure

4. (*a*) In making a measurement, the test specimen shall be positioned against the rear surface of the quadrant-separating baffle, covering the hole, and the light turned on. The photocell shall be positioned to give a full-scale or maximum reading on the galvanometer, at or near the specular angle, and any fluctuation or fatigue shall be noted. Fluctuation shall not exceed plus or minus 2.5 percent of the reading after correcting for nonlinearity of galvanometer response (Section 2 (*g*)).

NOTE. Lamp voltage fluctuations may be minimized by employing a voltage-regulating device in the lamp circuit.

(*b*) Measurements shall be made by either method A or method B. Method A includes the specularly reflected or transmitted component, while method B excludes it. The angles at which the center of the photocell is positioned to take readings for method A shall be as prescribed in Table I; for method B readings of groups 1 and 6 shall be omitted.

(*c*) At the conclusion of a test by either method, the photocell shall be placed accurately in the starting position and a reading taken on the galvanometer. This final reading shall check that made at the beginning of the test within plus or minus 2.5 percent, or the test shall be repeated.

(*d*) If the specimen is patterned or configurated in body or surface texture in a manner that may cause orientation of its diffusive properties, tests shall be made with each of the dissimilar axes of symmetry of the pattern in a vertical position and these positions shall be noted.

Numerical evaluation of diffusion

5. (*a*) The brightness readings shall be plotted as ordinates on Cartesian coordinates, employing the corresponding angle for each reading as the abscissa.

(*b*) A smooth curve shall be drawn through the points and extrapolated to zero at 90 deg. By means of a planimeter or other sufficiently accurate method, the areas under the brightness-distribution curve, separately for reflective and for transmissive determinations (S_r and S_t), shall be evaluated in any convenient or arbitrary units, from 3 to 90 deg. and from 90 to 177 deg., respectively (method A), or from 15 to 90 deg. and from 90 to 165 deg. (method B).

(*c*) The area ($S_{max.}$) included under a horizontal straight line at the maximum brightness reading shall be determined over the same angular extent and in the same units of area. This area is the rectangle that includes the brightness distribution curve for the specimen, within the angular limits corresponding to method A or method B.

(*d*) The reflective and trans- (*Please turn to page 102*)

TABLE I.—POSITIONS FOR TAKING BRIGHTNESS READINGS FOR METHOD A (INCLUDING SPECULAR COMPONENT)

Group	*Range of angle of observation, deg.*		*Intervals between readings, deg.*
	From	*To*	
1[a]	3	15	2
2	15	45	5
3	45	85	10
4	95	135	10
5	135	165	5
6[a]	165	177	2

[a] This group of readings shall be excluded for method B.

Zinc alloys for molds

by J. DELMONTE*

ZINC alloys have been of particular value to aircraft companies in the construction of dies for forming metal parts. They are readily cast to size and after a comparatively small amount of finishing are ready for service. Their big advantage of reducing machine work to a minimum has strong appeal, especially when time is an important factor. For this reason, experimentation with these alloys has been carried on in order to evaluate their usefulness as molds for plastics.

It would be rash to expect from zinc alloy plastics molds a life comparable to that of hardened steel alloys. While certain castable zinc alloys are comparatively hard, they still do not approach the hardness of steel. Nevertheless, there are applications usually requiring up to 1000 molded parts or less where hardened steel molds would be impractical because of the excessive mold cost per unit. It is in the fulfillment of these limited production requirements that zinc alloy molds may prove feasible. Zinc alloy molds will be lower in cost than equivalent steel molds because: 1) Machining costs are very much reduced as the zinc alloy is cast approximately to size in suitable patterns; 2) the zinc alloy may be remelted an indefinite number of times and used in the construction of other molds; and 3) the time required to develop a polished surface in zinc alloy molds is considerably less than that required for steel molds.

The preparation of zinc alloy molds may follow somewhat conventional lines. The starting point would be an accurate model or pattern of the part to be reproduced. A sand pattern must be prepared which is a positive image of the final desired model. Then a negative model is cast in zinc alloy. This negative model may in turn be used to reproduce the positive desired objects.

The grade of sand in which the zinc alloy is poured should preferably be of a fine grain so as to minimize finishing operations on the cast metal. It is prepared in the conventional manner with 6 to 7 percent water providing a temporary binding action. The sand is not packed down too tightly, and thus permits volatile matter and gases to escape when the hot metal is poured around 900 deg. F. In preparing the sand pattern it is desirable to use some parting powder to provide a good release of the model or plaster casting which leaves its imprint in the sand. The zinc alloys will shrink .012 in. per linear inch, and to secure accurate dimensions some allowance must be made for this shrinkage. It is usually the preferred procedure to cast larger than necessary and machine and polish down to final dimensions. The zinc alloy used in these tests had a compressive strength of 60,000 to 75,000 p.s.i., and a tensile strength of 37,000 p.s.i.

As examples of some of the work done at the Institute with zinc alloy molds,[1] Figs. 1 and 2 show the zinc alloy molds for a small Chinese doll and an internal gear. In both cases approximately 30 to 50 molded parts were reproduced from these molds without resultant damage during their use. The metal was then melted down and re-employed in other molds.

Temperatures up to 380 deg. F. and molding pressures up to 10,000 lbs. per square inch were employed in using the zinc alloy molds in an effort to break them down but no dimensional changes occurred. Aside from these test cases, the molds were operated at temperatures and pressures recommended by molding material manufacturers. Several types of compression molding materials were used in the zinc alloy molds: phenolic, urea, cellulose (*Please turn to page 108*)

1, 2—Zinc alloy molds for a small Chinese doll and an internal gear. From 30 to 50 parts may be reproduced from these molds. 3—Zinc alloy mold mounted on steel plate. The mold is polished and plated with light nickel, chromium

1

2

3

* Plastics Industries Technical Institute.

[1] The alloy used in these experiments was Kirksite A, a zinc-base alloy containing also aluminum, copper and magnesium. It is widely employed for stamping dies by the aircraft industry for forming and trimming of sheet metal parts. It is manufactured by the National Lead Co., and is at present available only for high priority applications.

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Plastics at Memphis A.C.S. meeting

THE Plastics Group of the Division of Paint, Varnish and Plastics Chemistry of the American Chemical Society met in Memphis, Tenn., on April 22. The Chairman of the Division, Dr. S. L. Bass, had arranged a program of eleven papers covering various theoretical and applied aspects of high polymers. Abstracts of these papers are presented herewith.

INFRARED DATA ON THE STRUCTURE OF POLYSTYRENE. N. Wright, Dow Chemical Co.

A new infrared test for the presence of methyl groups in hydrocarbons has been applied in the case of polystyrene. The test hinges on the presence or absence of an infrared absorption band at 3.38 microns (2960 cm.$^{-1}$), requiring a higher resolving power than is obtained with the usual rock-salt prism spectrograph. In the present instance, a prism of lithium-fluoride has been used, and the infrared spectra of several examples of compounds are presented to demonstrate the validity of the test. Applied to polystyrene, this test has shown that no significant number of methyl groups is present. In the light of this fact, a discussion is given of the origin of the 7.35-micron (1360 cm.$^{-1}$) band of polystyrene which can no longer be regarded as indicating the presence of methyl groups. Other features of the infrared spectrum are discussed in relation to molecular structure.

THE FRACTIONATION OF POLYSTYRENE. T. Alfrey and H. Mark, Brooklyn Polytechnic Institute.

Polystyrene samples prepared under different conditions were fractionated by preferential solubility in solvent-nonsolvent systems. Polystyrene was dissolved in methyl ethyl ketone, and methanol or acetone was added until a gel phase began to appear. The mixture was warmed to dissolve the gel, and the desired gel fraction was obtained by slowly cooling the mixture. Some of the properties of fairly homogeneous polystyrene fractions were investigated. Phase diagrams for several ternary systems were obtained. The relation between specific viscosity and concentration was determined for each of the fractions. Several mixtures of different fractions were prepared. The molecular weight distribution curves of these mixtures could be considered to be known. These prepared mixtures were subsequently fractionated in order to determine directly the resolving power of the fractionation method. A theory of polymer fractionation was developed, based upon the work of Schultz, Huggins and Flory. The data obtained in the experimental investigation are interpreted in terms of this theory.

VISCOSITY AND CRYOSCOPIC STUDIES OF POLYSTYRENE. DISCUSSION OF STAUDINGER'S VISCOSITY RULE. A. R. Kemp and H. Peters, Bell Telephone Laboratories.

From cryoscopic and viscosity data, a $K_{sm.}$ value for polystyrene of 0.45×10^4 is established for use in the viscosity-molecular weight equation:

$$M = \frac{\log \eta r}{C} \times K_{sm.}$$

This value is less than one-third that selected by Staudinger for polystyrene, ranging in molecular weight from 7000 to 13,000 determined by the cryoscopic method. Cryoscopic data at various concentrations are presented on narrow fractions of polystyrene ranging in molecular weight from about 300 to 3000. From these data, it is shown that solutions of polystyrene in benzene exhibit increasing deviation from Raoult's law as the molecular weight increases beyond about 1000. This fact shows why the present $K_{sm.}$ value, based only on ideal solutions, is so much lower than Staudinger's value, based on higher polymers whose solutions deviate widely from Raoult's law.

It is confirmed that the well-known Staudinger viscosity-molecular weight rule cannot be applied to different polymers. The Staudinger $K_{sm.}$ equivalent based on the present authors' results is more than 300 percent higher than Staudinger's value. A new $K_{sm.}$ equivalent for one chain atom is calculated for various polymers, based on the number of chain atoms in the base molecule, the $K_{sm.}$ value and the weight proportion of chain atoms to the base molecular weight. A wide variety of linear polymers give $K_{sm.}$ equivalents, ranging from 2.2×10^4 to 4.8×10^4, depending on influences of solvent, side groups, etc.

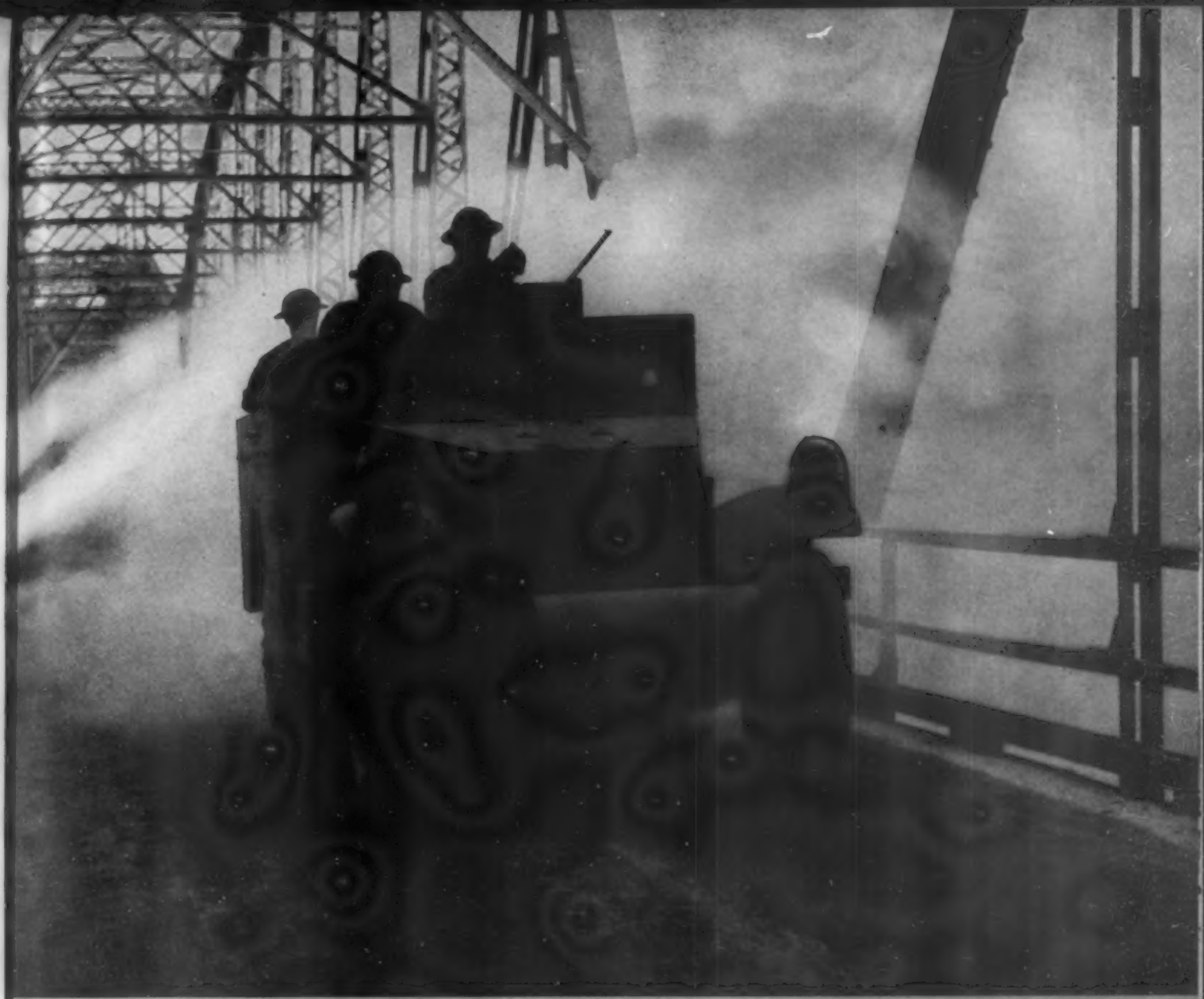
CRYOSCOPIC AND VISCOSITY STUDIES OF POLYISOBUTYLENE. CRYOSCOPIC DEVIATION OF POLYISOBUTYLENE SOLUTIONS FROM RAOULT'S LAW. A. R. Kemp and H. Peters, Bell Telephone Laboratories.

Cryoscopic and viscosity measurements on low polymeric isobutylene have led to an accurate determination of the $K_{sm.}$ constant to be used in the viscosity-molecular weight equation. A $K_{sm.}$ value of 0.75×10^4 was found in contrast with values of 1.4×10^4 obtained by Staudinger. Data are presented showing that $K_{sm.}$ increases from 0.60×10^4 for a trimer to a constant value of 0.75×10^4 as the molecular weight approaches 1000. It is shown that cryoscopic deviation from Raoult's law begins when the molecular weight of polyisobutylene exceeds about 2300 corresponding to a chain of about 80 carbon atoms. Solvent effects were investigated and the viscosity of benzene solutions of polyisobutylene are shown to act anomalously, whereas solutions in *n*-hexane and certain other solvents behave in a regular fashion. It is shown that a combination of diffusion and precipitation procedures is effective in fractionating mixed isobutylene polymers.

THEORY OF SOLUTIONS OF HIGH POLYMERS. Maurice L. Huggins, Eastman Kodak Co.

The theoretical derivation of equations for the thermodynamic activities of the components of a solution of chain molecules is briefly outlined. From these, equations for the dependence of osmotic pressure and related properties on composition are deduced. Comparisons of calculated and experimental data show excellent agreement, both for solutions of short chain molecules and for solutions containing very long chains. The theoretical treatment should be applicable also to systems containing flexible network molecules or gels. Equations are given for the limiting conditions necessary for gel formation and for the solubility of a small molecule solvent in a gel. The factors determining the solubility of high polymers in small molecule solvents are discussed. Theoretical equations for solubility are derived and compared with experimental results.

(Please turn to page 100)



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Plastics digest

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General

PLASTICS RESEARCH IN CANADA. W. Gallay. Can. Chem. and Process Industries *25*, 635–8 (Dec. 1941). A review of the work in the plastics laboratory of the Division of Chemistry, National Research Council, at Ottawa is presented. Particular attention has been directed to adhesives for both molded and flat plywood for aircraft construction. Curing temperatures, resistance to crazing in the glue line, and sensitivity to moisture content in the veneers are factors that have been investigated. Propellers and certain airframe members made of compregnated wood have yielded excellent results in extensive trials. In the application of plastic molding compounds for military purposes, improvement in the impact strength has been constantly sought.

WHAT THE PRODUCT DESIGNER SHOULD KNOW ABOUT PLASTICS. E. Furholmen. Machinery *48*, 141–4, 199–203 (Mar., Apr. 1942). The characteristics and types of applications of plastics are listed and directions for the design of plastic molded parts for economical quantity production are given. The use of plastics is especially advantageous where one or more of the following conditions must be met: dielectric; shapes having thin walls of fairly uniform sections; elimination of an applied finish; colors or decorative effects; transparency, translucency or special opaque effects; minimum weight; corrosion resistance; low thermal conductivity; wear resistance; unusually smooth surfaces; freedom from odor and taste; resistance to moisture; moldability around inserts; and a considerable degree of resilience.

COST FACTORS GOVERNING DESIGN PLASTICS. J. Delmonte. Machine Design *14*, 70–3 (Mar. 1942). Various curves are presented to show labor and material costs as a function of the number of pieces and the number of cavities. Advantages of machining standard sheets, rods and tubes for low productions are indicated. It is pointed out that both molding and machining on the same article may effect economical production.

Materials and Manufacture

THE CHANGING FASHION OF POLYMERS. R. H. Kienle. Brit. Plastics *13*, 333–6 (Feb. 1942). The author presents an outline of plastics development as influenced by availability of raw materials, demands of various key industries, and scientific investigations.

PLASTICS IN PRODUCTION. K. J. Leeg. Iron Age *149*, 42–5 (Feb. 12, 1942). Properties, present uses and possible applications of a new cast phenolic resin are described. The resin was developed to meet specialized needs in oil well equipment, replacing cement in making guide shoes. It was found to be suitable for the molds needed in the casting process. While the plastic molds do not have the life of brass molds, the cost of machining brass molds is high, and the over-all cost of plastic pieces made in plastic molds is lower than that of castings made in brass molds. The resin is said to be particularly suitable for dies used by aircraft manufacturers in fabricating thin metal sheets. It has proved satisfactory for all types of sheet metal forming, with the exception of impact forming, on aluminum and stainless steel sheets up to .040 in. in thickness. The resin cures in 2 hours at 180 deg F. The use of walnut shell flour as a filler for this type of resin was discussed in the Feb. 1942 issue of MODERN PLASTICS, p. 37.

SYNTHETIC RESIN VARNISH FOR COIL INSULATION. L. E. Frost and G. L. Moses. Product Eng. *13*, 144–6 (Mar. 1942). The development of fibrous glass insulation a few years ago made it clear that the ordinary types of organic varnishes were the bottleneck to high-temperature insulation development. New synthetic resin thermosetting varnishes have proved a distinct step forward in the insulation of electrical machinery. These provide good wet and dry dielectric strength, resistance to oil, weak acids and alkalies, and moisture, good penetration into voids and coil capillary openings, cure at reasonable temperatures, withstand high-temperature operation well and produce tough, resilient, flexible protective surface films with solid internal structure.

PLASTIC SHEET AND FILM MATERIALS. E. E. Halls. Plastics *6*, 9–13, 62–4 (Feb., Mar. 1942). Further data on the moisture permeability of rubber, Pliofilm and cellulosic films of various types are tabulated and discussed. In thinner gages the rate of passage of water vapor through a material increases with thickness. . Above a certain optimum thickness the rate is constant independent of thickness. Thinner layers of plastics are less costly than paper materials from the standpoint of moisture permeation. (See Digest Page in March issue for abstract of Part I of this article.)

Applications

BALLOONS FOR METEOROLOGICAL RESEARCH. Plastics *6*, 45–9 (Mar. 1942). The defects of rubber with respect to resistance to ultraviolet light and to ozone become much more pronounced at high altitudes. Experimental work with balloons made of regenerated cellulose films is described. These are folded into various geometric constructions which open up gradually during ascent instead of depending on expansion of a spherical elastic bag. A black lacquer is applied to these balloons to maintain the temperature of the envelope at 10 to 20 degrees above that of the surrounding atmosphere.

RESIN-BONDED WOOD LAMINATES FOR SHELL TYPE AIRCRAFT STRUCTURES. A. A. Gassner. J. Aero Sciences *9*, 161–71 (Mar. 1942). Wood veneers in combination with synthetic resins yield a material exceedingly well suited for the construction of full-stressed shells for aircraft parts with very few internal stiffeners. Surface coating with synthetic resin or resin impregnation of the basic veneers makes these structures highly impervious against moisture. Stress analysis methods for tensile and compressive loads are developed and their application to design of specific parts is illustrated.

SYNTHETIC RESINS IN AIRCRAFT CONSTRUCTION. H. N. Haut. Aviation *41*, 84–5, 103, 105, 210, 213–4 (Mar., Apr. 1942). The development of synthetic resins for bonding wood veneers in the molding of aircraft is reviewed. Results of tests on various types of resins are presented. It is reported that a phenolic resin curing at about 140 deg. F. proved to be definitely superior to other types of bonding mediums commonly used in airplane assemblies.

PLASTICS THAT CAN HELP THE SHIPBUILDING INDUSTRY. A. C. Hardy. Plastics *6*, 52–9 (Mar. 1942). Factors which are likely to affect the design of the ships of tomorrow are discussed. Plastics are classed with light metals, welding, and aircraft streamlining technic as elements likely to greatly influence the shape and weight of ship structures in the future. The types of ships which can use plastics are listed. Marine applications of plastics are subdivided into mechanical, structural and decorative groups. Mechanical parts include bearings, stern tubes and cable coverings. Potential structural parts are hatch covers, wheelhouse, lifeboats, steering wheels, thermal insulation and windows. Decorative items include paneling and cabin fittings. Questions with which shipbuilders are concerned relate to comparative properties of plastics and metals, corrosion-and weather-resistance, strengths at joints, ease of repair, reaction to rapid changes of temperature, fire-resistance and ability to be refinished.

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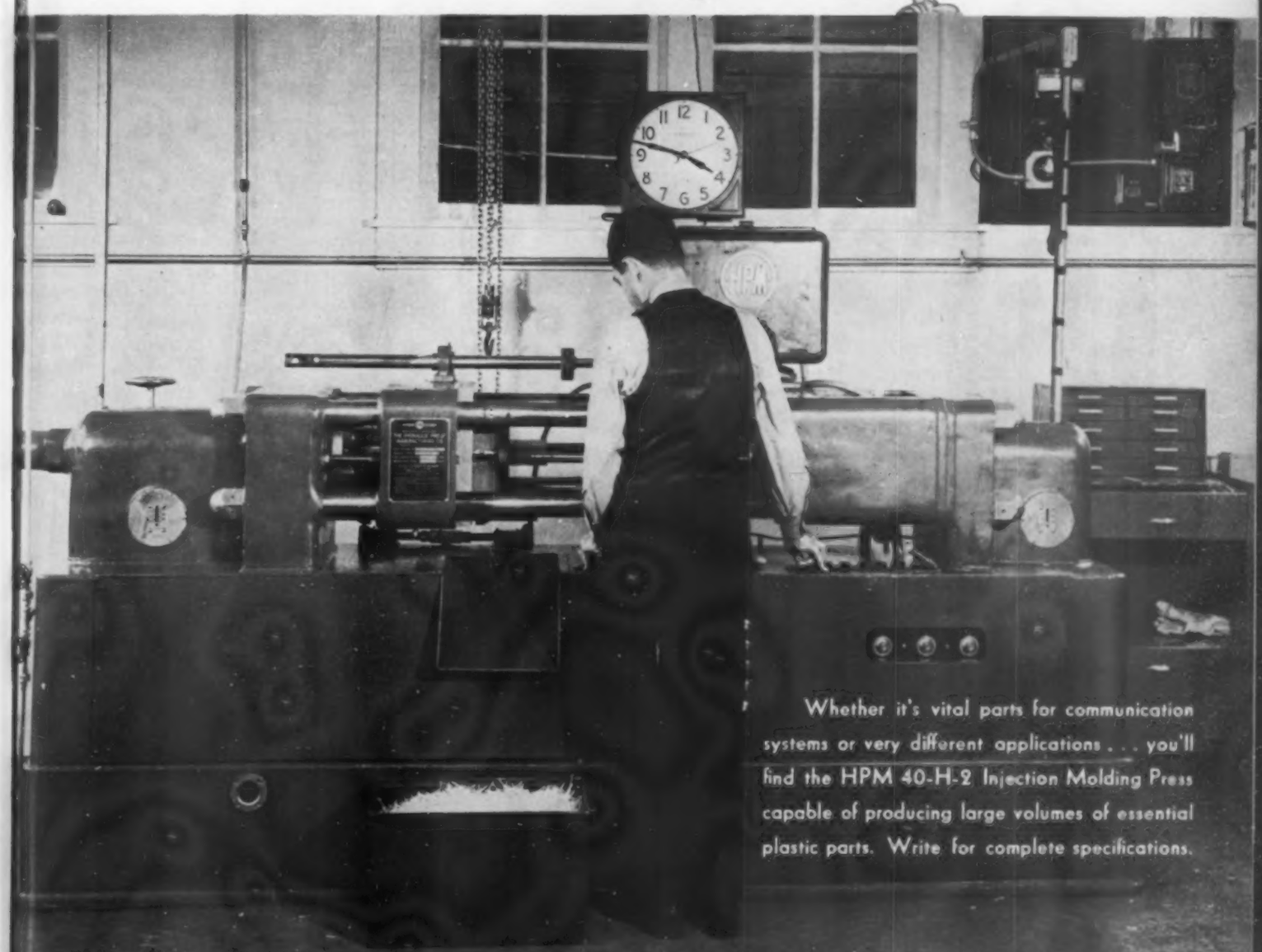

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Technical briefs

Abstracts of articles on plastics in the world's scientific and engineering literature relating to properties and testing methods, or indicating significant trends and developments

Engineering

VINYON SCREEN PRINTING CLOTH. Rayon Textile Monthly *23*, 74 (Jan. 1942). Fabric made from vinyl chloride-acetate resin is not affected by soaking in water, 5 percent caustic soda and 30 percent glycerol, whereas silk bolting cloth is considerably affected. The synthetic fabric maintains a firm drum-like tension on the frame, wet or dry. It does not absorb dye and is easily washed. Vinyon may be stored for long periods without deterioration. It is not satisfactory at temperatures above 150 deg. F.

FIRST RESULTS OF APPLICATION OF FAOLITE TO INDUSTRIAL PRODUCTION. M. K. Amusin. Korroziya i Borba s Nei *5*, No. 3–4, 119–32 (1939); Chem. Abstracts *36*, 1109 (1942). Details concerning the manufacture of Faolite, a phenol-formaldehyde resin with anthophillyte filler (essentially a magnesium ferrous silicate) are given. The product has satisfactory mechanical properties and good resistance to chemicals. It has been used in equipment for citric acid manufacture, Friedel-Craft synthesis of ethylbenzene, drying chlorine and electroplating.

Chemistry

SYMPOSIUM ON HIGH POLYMERS. Ind. Eng. Chem. *34*, 449–79 (Apr. 1942). This group of papers includes six of the ten papers on high polymers presented at the Sept. 1941 meeting of the American Chemical Society. The subjects and authors are as follows: "Phase Transition and Elastic Behavior of High Polymers," by H. Mark, pages 449–54; "Physical Properties of Polystyrene as Influenced by Temperature," by T. S. Carswell, R. F. Hayes and H. K. Nason, pages 454–7; "Methyl Methacrylate Polymerization. Peroxide Catalysis and the Oxidation of Hydroquinone Inhibitor," by H. N. Alyea, J. J. Gartland, Jr., and H. R. Graham, Jr., pages 458–60; "Solubility of Polybutene in Pure Solvents," by H. C. Evans and D. W. Young, pages 461–6; "Solvents and Plasticizers for Chlorinated Rubber," by J. W. Raynolds, M. R. Radcliffe and M. R. Vogel, pages 466–73; "Pyrolysis of Lactic Acid Derivatives. Conversion of Methyl α-Acetoxypropionate to Methyl Acrylate," by Lee T. Smith, C. H. Fisher, W. P. Ratchford and M. L. Fein, pages 473–9. Abstracts of these papers were published on pages 80–1 of the October 1941 issue of MODERN PLASTICS.

FRACTIONATION AND SIZE DISTRIBUTION IN VINYL ACETATE POLYMERS. R. A. Blease and R. F. Tuckett. Trans. Faraday Soc. *37*, 571–80 (Nov. 1941). Commercial polyvinyl acetates of three different average chain lengths were fractionated from toluene solution by a precipitation method using a methanol-water mixture. The fractionation data are in fair agreement with the theory of the solubility of high molecular weight substances advanced by Schulz. From the size-distribution data thus obtained, combined with the Melville-Gee theory of the kinetics of polymerization, it is concluded that the growing chains are most probably terminated by mutual collision, in agreement with the purely kinetic data.

Properties

PROPERTIES OF CELLULOSE ESTERS OF ACETIC, PROPIONIC AND BUTYRIC ACIDS. C. J. Malm, C. R. Fordyce and H. A. Tanner. Ind. Eng. Chem. *34*, 430–5 (Apr. 1942). The relationships between properties and compositions of both the simple and mixed cellulose esters of acetic, propionic and butyric acids are presented in graphic form. The properties shown are melting point, specific gravity, moisture sorption and solubility in solvents and plasticizers. The data can be used to select esters with specific properties.

ELECTRICAL PROPERTIES OF SOLIDS. XII. PLASTICIZED POLYVINYL CHLORIDE. D. J. Mead, R. L. Tichenor and R. M. Fuoss. J. Amer. Chem. Soc. *64*, 283–91 (Feb. 1942). Data at 40 and 60 deg. C. and 60, 600 and 6000 cycles are given for polyvinyl chloride plasticized with 8 to 30 percent by weight of the following compounds: Tetralin, diphenylmethane, diphenylmethylmethane, dibenzyl, amylnaphthalene, distyrene, di-α-methylstyrene, diphenoxyethane, dibenzyl ketone, dibenzyl maleate, dibenzyl succinate, dibenzyl phthalate, dibenzyl sebacate and dioctyl phthalate. Plasticization is essentially a separation of chain molecules by the plasticizer molecules, accompanied by a rapid decrease in microscopic and macroscopic coefficients of friction. A simple empirical relationship connecting loss factor and plasticizer concentration is given. Very roughly, the viscosity varies inversely as the third or fourth power of the relative concentration, depending on the temperature. The concentration at which a given plasticizer produces a given internal viscosity, as measured by a characteristic electrical response, depends on the size and shape of the plasticizer molecule. A long cylindrical molecule is more effective in reducing viscosity than a spherical molecule of the same molecular weight Plasticizers of about the same size and shape are about equally effective as plasticizers, regardless of their chemical structure, except that a polar or polarizable group must be present in the plasticizer in order for it to interact with the vinyl chloride polymer.

Testing

TURBIDIMETRIC DETERMINATION OF POLYMERIZED HYDROCARBONS IN SOLUTION. B. Ferguson, Jr., and M. D. Snyder. Ind. Eng. Chem., Anal. Ed. *14*, 135 (Feb. 1942). The amount of styrene polymer present in solvents is determined by the turbidity produced by adding suitable diluents until precipitation takes place.

FRICTIONAL PHENOMENA. VI. THE MEASUREMENT OF THE VISCOSITY OF LIQUIDS. A. Gemant. J. Applied Physics *13*, 22–9 (Jan. 1942). A brief review of the principles and methods used for the measurement of the viscosity of liquids is presented. The four chief principles are: Flow in capillaries, shear between walls, falling spheres and damping of waves. Fields of application and limitations of each method are discussed. A relatively new instrument, the oscillation-viscometer, is dealt with in some detail.

ESTIMATION OF FREE PHENOL IN PHENOLIC PLASTICS. C. A. Redfarn. British Plastics *13*, 139 (1941). An iodimetric method for determining free phenol in phenolic plastic drillings. Results are likely to be high because of the presence of other substance which may react with free iodine.

DETERMINATION OF PARTICLE SIZE DISTRIBUTION FOR PARTICLE SIZES BETWEEN 40 AND 1 OR 2 MICRONS. W. O. Hinkley. Ind. Eng. Chem. Anal. Ed. *14*, 10–13 (Jan. 1942). Particle size finer than 40 microns is determined by a variation of the pipet method of Oden. In this modification the amount of solids is determined by use of a specific gravity bottle instead of drying the pipetted sample and weighing the residue. The method is rapid and utilizes relatively inexpensive apparatus.

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U. S. Plastics Patents

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SURGICAL DRESSING. E. F. Klein (to Raritan Bay Holding Co.). U. S. 2,273,873, Feb. 24. Transparent tape for wound dressings is coated on both sides with a transparent adhesive and covered with a separator tape.

MOISTUREPROOF FOILS. J. A. Mitchell (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,273,880, Feb. 24. Coating transparent wrapper foils first with a butadiene anchor coat and then with a moistureproof lacquer.

CELLULOSIC PRODUCT. F. T. Peters (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,273,890, Feb. 24. Stabilizing softened regenerated cellulose articles by adding an aminoiminosulfoxylic acid.

POLYMERIZATION. M. A. Pollack, I. E. Muskat and F. Strain (to Pittsburgh Plate Glass Co.). U. S. 2,273,891, Feb. 24. Oxygenated compounds with multiple but unconjugated unsaturation are polymerized in two stages, unchanged monomer being removed after the first stage.

SEMISTIFF COLLAR. M. L. Kaplan (to Celanese Corp.). U. S. 2,273,965, Feb. 24. Joining the inner and outer plies of a collar by interposing a cellulose derivative interliner, moistening with a solvent and pressing on cold smooth plates.

LEATHER SUBSTITUTE. R. C. Medl, Jr. (to Hercules Powder Co.). U. S. 2,273,973, Feb. 24. Artificial leather which resists both heat spewing and cold embrittlement is made by coating fabric with pigmented nitrocellulose containing bodied rapeseed oil and butyl acetylricinoleate.

OILPROOF SYNTHETIC RUBBER. Emil Ott (to Hercules Powder Co.). U. S. 2,273,983, Feb. 24. Compounding chloroprene rubber with gasoline-soluble chlorinated paraffin to make oilproof compositions.

PULP MOLDINGS. E. E. Sawyer (to Keyes Fibre Co.). U. S. 2,274,095, Feb. 24. Molding dishes and the like from superposed layers of resin-bearing fiber.

FILMS. G. C. Mack (to Wingfoot Corp.). U. S. 2,274,150, Feb. 24. Casting rubber hydrochloride films on a support, evaporating part of the solvent, stripping off the film and stretching it.

SLIDE FASTENER. N. J. Poux (to Talon, Inc.). U. S. 2,274,161, Feb. 24. Molding slide fastener units with connected top and bottom wings.

MOLDING DEVICE. C. H. Brace (to General Refineries, Inc.). U. S. 2,274,186, Feb. 24. In molding apparatus for investing patterns in vacuum the flask is open at its ends and communicates with an ebullition chamber.

FISH LINE. J. E. Pierce (to Pierce Plastics, Inc.). U. S. 2,274,255, Feb. 24. A fish line which floats on water is tubular and is made of a thermoplastic with high tensile strength.

COLLAPSIBLE TUBE. Walter A. Roselle. U. S. 2,274,258, Feb. 24. A tube type of container has its metal foil lined with a plastic film, and is fitted with a molded top.

MOLD. F. H. Shaw (to Shaw Insulator Co.). U. S. 2,274,279, Feb. 24. A multiple pressure molding machine has a die fed by a supply chamber under pressure from inner and outer force plugs.

TREATING EARTH. C. Irons and Sylvia M. Stoesser (to Dow Chemical Co.). U. S. 2,274,297, Feb. 24. Injecting a resin solution into earth or rock formations to form a solid resin.

COATING VENEERS. Leonard E. Repsher and Chas. W. Hammond. U. S. 2,274,432, Feb. 24. Apparatus for extruding a plastic sheet onto veneer.

UREA RESINS. T. S. Hodgins and A. G. Hovey (to Reichhold Chemicals, Inc.). U. S. 2,274,447, Feb. 24. Use of mono- and dialkyl phosphates as acid accelerators for conversion of acid-convertible urea resins.

ROSIN ALCOHOLS. J. N. Borglin (to Hercules Powder Co.). U. S. 2,274,523–4, Feb. 24. Separating Hyex rosin alcohols into components, e.g., removing color components, by selective solvent action.

SELF-COLORED RESINS. W. O. Kenyon, L. M. Minsk and G. P. Waugh (to Eastman Kodak Co.). U. S. 2,274,551, Feb. 24. Joining the aryl radical of a resinous aromatic polymer to an azo dye coupling component.

VINYL CHLORIDE RESIN. A. B. Japs (to B. F. Goodrich Co.). U. S. 2,274,555, Feb. 24. Heat-stable, lightfast vinyl chloride resins contain a plasticizer and an ester of a drying oil acid and a monohydric alcohol.

CELLULOSIC PLASTIC. B. M. Vanderbilt (to Commercial Solvents Corp.). U. S. 2,274,568, Feb. 24. Plasticizing cellulose esters or ethers with a mixed phthalate ester in which one of the esterifying alcohols is a nitro compound.

TRANSPARENT FOIL. W. C. Calvert (to Wingfoot Corp.) U. S. 2,274,588, Feb. 24. Stabilizing rubber hydrochloride foils by dispersing therein barely sufficient alkali to neutralize any residual hydrochloric acid.

QUICK-SETTING RESINS. J. W. Raynolds (to Raolin Corp.). U. S. 2,274,616, Feb. 24. Accelerating the curing of vinyl chloride resins by adding 1 to 3 percent of a thiuram sulfide.

SAFETY GLASS. B. J. Dennison (to Pittsburgh Plate Glass Co.). U. S. 2,274,672, March 3. Using a partially acetalized vinyl resin, plasticized with ethyleneglycol dioctoate, as interlayer in safety glass.

LIGHT POLARIZER. L. A. Keim (to Pittsburgh Plate Glass Co.). U. S. 2,274,706, March 3. Forming a film of vinyl acetal resin containing oriented light polarizing crystals and joining it to a vinyl resin sheet.

SLIDE FASTENERS. D. Marinsky (one-half to L. H. Morin). U. S. 2,274,722, March 3. Forming end stops on slide fastener stringers having cellulose acetate links.

LOCK SLIDER. L. H. Morin (one-half to D. Marinsky). U. S. 2,274,723, March 3. An automatic lock slider for slide fasteners.

(*Please turn to page 80*)

PLAN OF ATTACK

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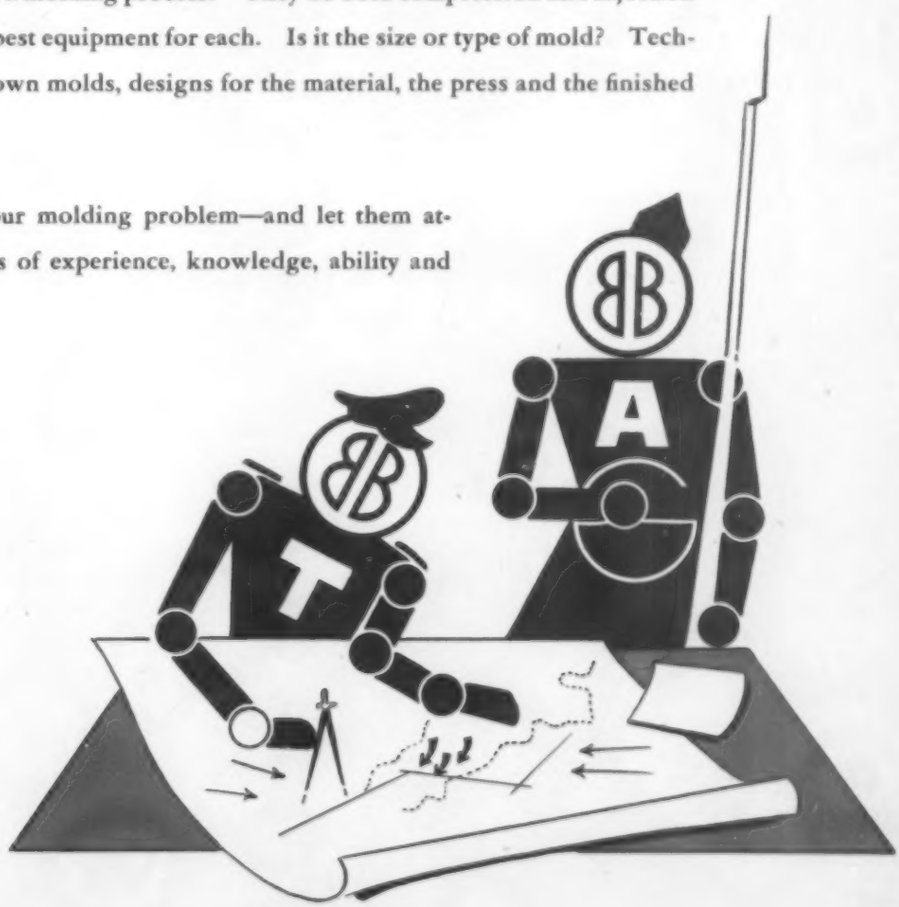

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INTERPOLYMERS. W. H. Smyers (to Standard Oil Development Co.). U. S. 2,274,749, March 3. Interpolymerizing an olefin (propene or higher) with a hydrocarbon of the styrene type.

TENNIS RACKET. John Hatton. U. S. 2,274,788, March 3. A molded handle, with tubular reinforcement, for tennis rackets.

SUPERPOLYAMIDES. J. W. Hill (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,274,831, March 3. Forming polyamide resins from two components, one of which has a tertiary nitrogen atom in the carbon chain.

WALL COVERING. G. Schneider (to Celanese Corp. of America). U. S. 2,274,851, March 3. Bonding rayon to a paper backing with a preformed film of a plasticized cellulose derivative.

HIGH POLYMER. E. Lieber and M. E. Thorner (to Standard Oil Development Co.). U. S. 2,274,864, March 3. Polymerizing an alcohol of the vinyl type to a resin which is nonvolatile at 600 deg. F.

SOY CASEIN. R. H. Hieronymus (to Drackett Co.). U. S. 2,274,983, March 3. Treating soy bean protein with alkali and then with hydrogen peroxide to prepare it for use in adhesives.

POLYAMIDE RESIN. D. D. Coffman (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,275,008, March 3. Insolubilizing water-soluble linear polyamides by treatment with an organic compound of nitrogen, phosphorus or sulfur.

CONTAINER. G. A. Moore (to Humoco Corp.). U. S. 2,275,063, March 3. A blank built up from fiber and foil layers is formed into a tube and the seam is sealed with a thermoplastic adhesive lacquer.

PRINTING INK. C. Ellis (to Ellis Laboratories, Inc.). U. S. 2,275,101, March 3. A solid fusible ink is made of pigmented sulfur, plasticized with a sulfur chloride-cresylic acid resin.

ADHESIVE GREASE. J. C. Zimmer and A. J. Morway (to Standard Oil Development Co.). U. S. 2,275,123, March 3. Improving lubricant greases by adding up to 5 percent of a mixture of high isobutene polymer and acrylic resin.

CELLULAR PLASTIC. R. M. Thomas and W. J. Sparks (to Standard Oil Development Co.). U. S. 2,275,164, March 3. Forming rounded particles of porous thermoplastic by vaporizing a solvent within the particles.

INSULATED WIRE. W. I. Patnode and W. J. Scheiber (to General Electric Co.). U. S. 2,275,198, March 3. Coating wire with a superpolyamide compounded with shellac.

PIGMENT PASTE. W. A. Waldie (to New Wrinkle, Inc.). U. S. 2,275,239, March 3. A pigment paste for fine textured wrinkle finishes contains bodied oils and a modified phenol-aldehyde resin.

CURING CONCRETE. Edw. W. Scripture, Jr. U. S. 2,275,272, March 3. Coating fresh concrete with a solution of an unsaponifiable wax and a vinyl chloride-vinyl acetate resin, rubber hydrochloride or the like.

DEPOLARIZER. Ernst Berl. U. S. 2,275,281, March 3. A layer of conductive activated carbon is bound to a porous support in an electric battery by a high substituted waterproof alkali-resisting cellulose ether.

TRANSPARENT FOIL. E. Czapek (to Guaranty Trust Co.). U. S. 2,275,289, March 3. Odorless crease-resisting wrapping foils have a coating of chlorinated rubber and chlorinated paraffin, then a finish coat of cellulose ester.

LUMINOUS EFFECTS. J. F. Dreyer (to Formica Insulation Co.). U. S. 2,275,290, March 3. Impregnating fabric with a urea resin varnish containing a fluorescent dye, joining it to a reflecting support and facing it with a sheet of fiber impregnated with urea resin varnish.

DISPLAY CONTAINER. John B. Foley. U. S. 2,275,293, March 3. A transparent cylindrical container has a transparent inverted cone for holding articles to be displayed.

VENEERS. G. G. Pierson (to Perkins Glue Co.). U. S. 2,275,314, March 3. Gluing veneers with starch containing a potential urea resin.

FOILS. W. H. Charch and F. P. Alles (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,275,347-8, March 3. Toughening cellulosic foils by drying in two stages, first without tension, then under tension.

PLASTICIZERS. F. J. Soday (to United Gas Improvement Co.). U. S. 2,275,383-4-5-6, March 3. Mono- and dialkyl esters of 4-methyltetrahydrophthalic acid; cellulose derivatives plasticized with dibutyl 4-methyltetrahydrophthalate; mono- and dialkyl 3-methyltetrahydrophthalates; and a process for esterifying 3-methyltetrahydrophthalic acid with amyl alcohol.

MOLDING COMPOSITION. Elvin M. Bright (to John M. Wallace). U. S. 2,275,499, March 10. Fusing silica with sulfur and mixing the melt with asphalt to make a plastic material.

INJECTION MOLDINGS. J. H. Leonard (to Standard Products Co.). U. S. 2,275,591, March 10. Injection moldings are formed around an insert by forcing separate streams of the plastic together in the cavity.

STRIP FILM. H. H. Duerr and F. W. H. Mueller (to General Aniline and Film Corp.). U. S. 2,275,617, March 10. Film with a cellulosic base layer has a subbing layer, an adhesive layer of alginic acid or the like, a cellulose ester layer and another subbing layer under the emulsion.

SUPERPOLYMERS. C. S. Fuller (to Bell Telephone Laboratories, Inc.). U. S. 2,275,620, March 10. A cold-drawing polyester which resists molecular degradation even in hot air is stabilized by being completely esterified.

VINYL RESINS. M. Salo (to Eastman Kodak Co.). U. S. 2,275,685, March 10. Reacting polyvinyl acetate, propionate or butyrate with a dicarboxylic acid anhydride to form mixed esters.

PLASTIC SHEETING. G. B. Bachman and C. N. Behrndt (to Eastman Kodak Co.). U. S. 2,275,716, March 10. Adding up to 5 percent of a dialkyl sulfosuccinate to a solution of cellulose ester and plasticizer to facilitate stripping cast films of the plastic from their base.

NITROCELLULOSE. J. L. Patterson (to Eastman Kodak Co.). U. S. 2,275,805, March 10. In refining nitrated wood pulp a certain proportion of nitrocotton is added.

ANTIHALATION FILM. C. R. Fordyce and J. Emerson (to Eastman Kodak Co.). U. S. 2,275,817, March 10. The transparent support of a photographic film has an antihalation backing of gum arabic phthalate.

UREA RESIN CEMENT. A. M. Howald and K. D. Meiser (to Plaskon Co., Inc.). U. S. 2,275,821, March 10. A delayed-setting adhesive is made by fixing the free formaldehyde in a solution of urea resin with ammonia and evaporating off the solvent.

CONDENSATION PRODUCT. Edwin T. Clocker. U. S. 2,275,843, March 10. Condensing a short chain unsaturated acid with a hot drying oil and esterifying the product with a polyhydric alcohol.

OIL-SOLUBLE RESIN. Israel Rosenblum. U. S. 2,275,865, March 10. Condensing a phenol with formaldehyde, a ketone and a terpene or terpene alcohol.

(Please turn to page 82)

Metal Department
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COATED PAPER. F. Groff (to Carbide and Carbon Chemicals Corp.). U. S. 2,275,957, March 10. Coating a hard nonporous paper with a detachable film of vinyl resin.

ROSIN PRODUCTS. A. L. Osterhof (to Hercules Powder Co.). U. S. 2,275,986, March 10. Condensing rosin or a rosin ester with a phenol.

LAMINATED SHEETING. E. R. Perry (to Westinghouse Electric and Mfg. Co.). U. S. 2,275,989, March 10. Compacting fibrous layers together with the aid of a resinous binder.

PRINTING PASTE. D. H. Powers and S. N. Glarum (to Rohm and Haas Co.). U. S. 2,275,991, March 10. Thickening aqueous printing pastes with a water-soluble alkyl cellulose or with sodium polyacrylate or a gum.

LAMINATED MOLDINGS. H. C. Guhl (to Westinghouse Electric and Mfg. Co.). U. S. 2,276,035, March 10. Fibrous sheets with a synthetic resin binder are molded in layers with curved contour by means of curved dies.

VINYL ESTERS. V. V. Alderman and W. E. Hanford (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,276,138, March 10. A polyvinylaryl ester.

FILM SUPPORT. J. E. Brandenberger (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,276,151, March 10. Facing a superficially hydrolyzed cellulose acetate foil on both sides with a regenerated cellulose foil, with a photosensitized stratum in one or both facing foils.

POLYTHIOAMIDES. D. D. Coffman and L. Gilman (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,276,160, March 10. Forming linear polymers from aminothiocarboxylic acids with a carbon chain of 5 or more atoms.

POLYTHIOAMIDES. N. L. Cox and W. E. Hanford (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,276,164, March 10. Forming linear polymers from thiolactams of amino acids with at least 5 carbon atoms.

VARNISH RESINS. R. B. Flint and H. S. Rothrock (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,276,176, March 10. Interpolymerizing an acrylate type ester with a tung oil type varnish.

CURLER. J. Hommer (to Lapin Products, Inc.). U. S. 2,276,196, March 10. A thin shell molded plastic curler.

ALKYD RESINS. H. J. West (to American Cyanamid Co.). U. S. 2,276,243, March 10. Condensing glycerol with phthalic anhydride in presence of an oil acid and melamine.

GREASEPROOF PAPER. H. C. Fisher, J. F. Thompson and W. E. Sooy (to Gardner-Richardson Co.). U. S. 2,276,244, March 10. Coating paper with glue, casein or soy casein, hardening with formaldehyde and coating the film with a resin solution,

RESIN SOLUTIONS. T. F. Bradley (to American Cyanamid Co.). U. S. 2,276,267, March 17. Alcohol solutions of alkyd resins derived from a polyglycol and an unsaturated polycarboxylic acid.

FILM. A. Hershberger (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,276,305, March 17. Adding up to 5 percent of an alkylamine soap to a solution for dry casting of vinyl acetal resin films.

CONDENSATION PRODUCT. H. G. Hummel and M. Jahrstorfer (to General Aniline and Film Corp.). U. S. 2,276,309, March 17. Condensing formaldehyde with derivatives of urea or of thiourea having a polyalkylene polyamine chain.

BUTTON. Henning W. Lindahl. U. S. 2,276,321, March 17. Molding buttons with a folded cord shank projecting from the center.

DIELECTRIC. Samuel Ruben. U. S. 2,276,346, March 17. A dielectric composition containing ethyl cellulose or benzyl cellulose and dimeric dihydronaphthalene.

POLYMERS. G. T. Vaala (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,276,437, March 17. Plasticizing linear polyamides with alkylaryl sulfonamides in which the alkyl group is butyl or higher.

CELLULOSE ETHERS. E. C. Britton and W. J. Le Fevre (to Dow Chemical Co.). U. S. 2,276,460, March 17. Etherifying alkali cellulose with a lower alkyl (methyl to amyl) halide to form a soluble ether.

LAMINATED FILM. D. L. Gibb and W. R. Collings (to Dow Chemical Co.). U. S. 2,276,478, March 17. Joining alternate ethyl cellulose and polystyrene foils to form a flexible sheet.

ALKALIPROOF COATING. J. L. Sherk and C. F. Cummins (to Dow Chemical Co.). U. S. 2,276,519, March 17. Adding a thermosetting oil-reactive phenolic resin to a cellulose ether lacquer.

DECORATIVE PANEL. Alice Donaldson. U. S. 2,276,567, March 17. A paper backing layer for decorative panels is impregnated with a transparent urea resin or an amber phenolic resin.

POLYSTYRENE. Herbert M. Stanley and Hanns P. Staudinger. U. S. 2,276,596, March 17. Interpolymerizing styrene or methylstyrene with a long chain (hexyl to dodecyl) alkyl crotonate.

FABRICS. Günther Bügge. U. S. 2,276,608, March 17. Producing woven fabrics from an artificial plastic material.

COATING WOOD. Elvin M. Bright (to John M. Wallace) U. S. 2,276,685, March 17. Bonding nitrocellulose covers to wood heels or the like by means of a primer film and a filler coating.

CONTINUOUS POLYMERIZATION. D. L. Gibb (to Dow Chemical Co.). U. S. 2,276,691, March 17. Producing lengths of solid polymer by continuous polymerization of a liquid in a mold.

RESINS. G. F. D'Alelio (to General Electric Co.). U. S. 2,276,828, March 17. Condensing urea with formaldehyde in presence of an amide or nitrile of malonic acid or a keto acid.

VINYLIMIDES. W. E. Hanford and H. B. Stevenson (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,276,840, March 17. Polymerizing N-vinylphthalimide.

ACIDPROOF LACQUER. H. C. Reynolds, Jr., and H. B. Kellogg (to Standard Oil Development Co.). U. S. 2,276,874, March 17. Hard, tough, acidproof, alkaliproof flexible films of cellulose esters or ethers are obtained by compounding the lacquer with a vinyl chloride type polymer.

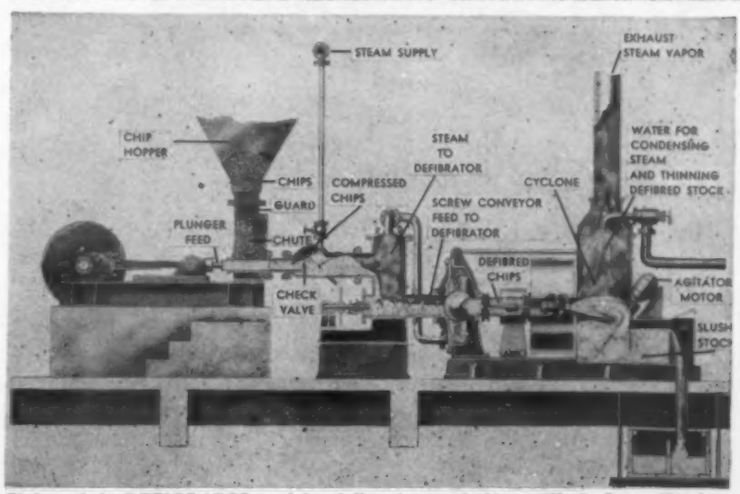
OLEFIN POLYMERS. R. M. Thomas and I. E. Lightbown (to Standard Oil Development Co.). U. S. 2,276,893, March 17. Low temperature polymerization of isobutene or the like to form viscous to solid polymers.

INSULATED WIRE. C. A. Webber (to Bell Telephone Laboratories, Inc.). U. S. 2,276,902, March 17. Flexible cable has concentric conductors insulated with braid impregnated with polyvinyl chloride, while the outer conductor is wound with polyvinyl chloride tape.

CHLORINATED POLYMER. H. W. Fisher (to Standard Oil Development Co.). U. S. 2,276,951, March 17. Coating a high isobutene polymer with a film, less than 10 mils thick, of chlorinated isobutene polymer.

The Asplund DEFIBRATOR *and* CHEMIPULPER

PATENTED AND PATENTS PENDING



Flofoto of the DEFIBRATOR used for defibrating wood chips. (U. S. Patent Numbers: 2,145,851—2,008,892—2,047,170. Canadian Patent Numbers: 337,404—335,302—355,303.) Patented in Foreign Countries.

Here is a machine that can help you solve your "Filler" problem. The Defibrator produces a new type of wood fibre pulp which serves as an excellent rag stock substitute for laminating and other molding purposes.

Many other types of fillers can be produced with the Defibrator. With changing conditions demanding considerable expansion of the laminating and molding fields along lines entirely different from those followed at the present time, it will pay you to investigate the possible application the Defibrator can perform to meet your particular requirements.

The remarkable results attained by users in many industries (over 210 Defibrators in successful operation) have proved the oustanding advantages of this defibrating process especially in the improvement of product quality and considerable reduction of production costs.

•

LITERATURE MAILED ON REQUEST

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Address Inquiries to R. D. KEHOE, *Sales Agent*

PAPER AND INDUSTRIAL APPLIANCES, Inc., 122 East 42nd Street, New York, N. Y.

Publications

Write direct to the publishers for these booklets. Unless otherwise specified, they will be mailed without charge to executives who request them on business stationery. Other books will be sent postpaid at the publishers' advertised prices

Materials of Engineering, 6th Edition

By Herbert F. Moore

Published by McGraw-Hill Book Co., 330 W. 42nd St., New York, 1941

Price $4.00 **454 pages, 158 illustrations**

With the ever-increasing range of applications of plastics for industrial purposes, this book should be of especial interest to those who make and use these synthetic materials. When plastics take their place along with metals, wood, glass and concrete as materials of engineering, it is necessary to have basic information on their physical properties in terms which have become established through years of testing of conventional structural materials. In the first seven chapters Professor Moore presents an elementary review of the general properties of materials, cohesion stress and strain, elastic strength of materials and failure of materials by flow or creep, fracture, corrosion and wear. Two chapters are devoted to discussions of testing methods and equipment and materials specifications. The remaining eleven chapters are concerned with the properties of specific groups of materials. It is noteworthy that in this sixth edition of the book a chapter on plastics has been added. G. M. K.

Chemical Engineers' Handbook, 2nd Edition

John H. Perry, Editor

McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, 1941
Price $10.00 **3029 pages**

This book provides both the practicing engineer and the student with an authoritative reference work that covers comprehensively the field of chemical engineering as well as important related branches of industry. The 29 sections have been prepared by a staff of specialists, and include physical and chemical data and principles, unit operations, materials of construction, fuels and power, and accounting and cost finding. All but four sections of the original edition have been rewritten or thoroughly revised, and many tables and chapters comprising new material have been added. G. M. K.

★ OF INTEREST TO AIRCRAFT DESIGNERS IS A booklet published by Rohm & Haas Co., Philadelphia, Penna., on methods of installing Plexiglas, the company's transparent acrylic sheet used for airplane enclosures. Suggesting that improper installation has frequently been responsible for cracking and crazing of the material, the booklet discusses the principles of successful installation under such headings as distribution of stresses, use of spacers, function of rubber gaskets, expansion and contraction clearances and recommended thicknesses. The section on channel and clamp mounting and on nut-and-bolt rivet mountings reproduces page-size installation sketches and discusses them.

★ ROBINSON MANUFACTURING CO., MUNCY, PA., describes and illustrates in its Catalog No. 36-E its line of crushers, cutters, grinders, hammer mills and pulverizers. Diagrams give sectional views of many of the machines, and full specifications are included.

★ IN A NEW BOOKLET ON CELLULOSE ACETATE, E. I. du Pont de Nemours and Co., Inc., Wilmington, Del., presents useful data and information on solvents, plasticizers and properties of the material in relation to its many fields of application, and describes the characteristics and specifications of its own cellulose acetate flake. Beginning with a comprehensive, classified listing of the uses of cellulose acetate plastics, the booklet continues with sections on the chemical constitution, definitive and other properties of cellulose acetate flake. A group of viscosity charts, and solvents, properties, and plasticizers charts accompanies these sections. The final pages are devoted to Du Pont cellulose acetate flake. A valuable reference handbook for acetate, its 18 pages are appropriately fastened with a roll binder of the material, and covers are transparent sheet.

★ SOUTH BEND LATHE WORKS, SOUTH BEND, IND., have issued the 41st edition of "How to Run a Lathe," with a number of changes in text material and illustrations to make it useful for defense training purposes. The handbook's 128 pages cover all phases of the care and operation of metal working lathes and are profusely illustrated.

★ FOR CONVENIENCE OF TECHNICAL MEN, JOHN Hassall, Inc., of Brooklyn, N. Y., manufacturers of nails, screws and rivets, has issued a chart of decimal equivalents printed in three colors to differentiate fractions and decimals.

★ THE NEW AND IMPROVED M. S. A. SINGLE FILTER, Dustfoe respirator is completely described in a bulletin issued by Mine Safety Appliances Co., Pittsburgh, Pa. Featured improvement of the Dustfoe is the new Single Filter which replaces the two-part (felt screen and cellulose) filters used previously. This new filter is all in one piece, giving U. S. Bureau of Mines-approved protection against an even broader range of dusts and mists, states the manufacturer. The filter is more porous on the outer side so that the larger dust particles are filtered out first, thus preventing rapid build-up of breathing resistance through clogging of filter.

★ THEIR LINE OF PRESSURE RECORDING INSTRUments is well illustrated and described by the Foxboro Co., Foxboro, Mass., in its new Catalog 22-A. A list of standard ranges of industrial pressure recorders is given, accompanied by full sized reproductions of specimen charts. Other sections of the catalog describe methods of instrument mounting, electrical signal systems and accessory equipment.

★ BOUND BROOK OIL-LESS BEARING CO., BOUND Brook, N. J., has put out a bulletin of installation data on Compo oil-retaining bearings which shows approved methods of installation of burnishing and boring tools, and gives information on eliminating reaming and machinery. The adaptation of this type of bearing to molded rubber, plastics and die castings is also detailed, and there are graphs which give data on shaft clearances and permissible loads.

★ THE BUREAU OF INDUSTRIAL AND TECHNICAL Education, State Education Dept., University of the State of New York, has published a Suggested Course of Study in Applied Textiles which is a revised and enlarged edition of a monograph brought out by the New York State Vocational and Practical Arts Association in 1939. The course of study is prepared for the use of vocational teachers, with special consideration for the needs of students in the wearing apparel industries, but may be used in other types of secondary schools giving training in buying and selling of clothing fabrics and homemaking and interior decoration. The lessons embrace the materials and processes used in the manufacture of fabrics, and identification and care of the finished fabrics. The 240-page, loose-leaf book covers a two-year course of study, divided into four terms, in the third of which the subject of rayon, rayon acetate and other synthetic fibers is treated.

Fast finishing on intricate parts

Product illustrated, courtesy American Insulator Co.

FINISHING costs dwindle as the number of operations per job are reduced. In the complicated molded product—a switchbase—shown above, a single file of proper cut and size is capable of removing fins, cleaning out square grooves and slots, touching up sliding or joining surfaces.

A few other file shapes within easy pick-up enable the operator to reach extra-narrow quarters or odd angles.

A thing of primary importance in plastics filing is to select files of the proper cut for the character of the molded material. Whether hard, soft, brittle or "shreddy," there's a Nicholson File that's right for the job. Send us a description of any product on which flash removal or other finishing details are a production problem. We can help you . . . and your mill-supply house can most likely provide the files the situation requires.

NICHOLSON *and* **BLACK DIAMOND** ***Files for Plastics*** include certain cuts of Flat, Mill, Square, Round and Half-round; several types of X. F. (Extra Fine) Swiss Pattern, including Knife and Pillar; the so-called Button and other types. The Nicholson Guarantee: *Twelve perfect files in every dozen.*

NICHOLSON FILE CO., PROVIDENCE, R. I., U. S. A.

(Also Canadian Plant, Port Hope, Ont.)

NICHOLSON FILES

FOR EVERY PURPOSE

NICHOLSON U.S.A. MADE IN U.S.A.

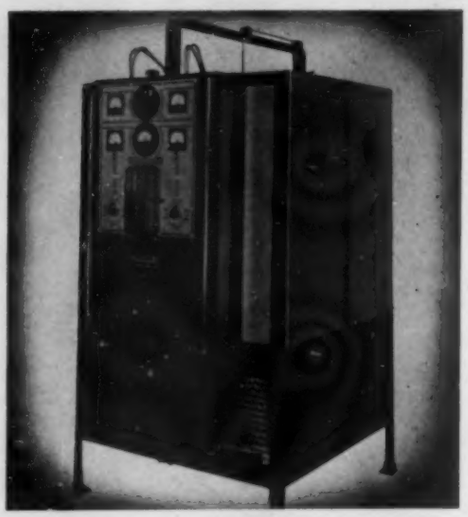
Machinery and Equipment

★ CAMBRIDGE INSTRUMENT CO., INC.'S NEW MULTI-Point pH Recorder, which shows continuously on a single chart simultaneous determinations of pH, is said to incorporate an advance in circuit design which permits installation of the measuring electrodes at separate and independent sampling points throughout the plant. Electrodes are connected electrically to the recorder, which may be a considerable distance away. Simultaneous records of pH at separate and independent points in a fluid-flow system can be utilized to provide a continuous "before and after" picture of pH, and thus enable the operator to see the effectiveness of the process in use.

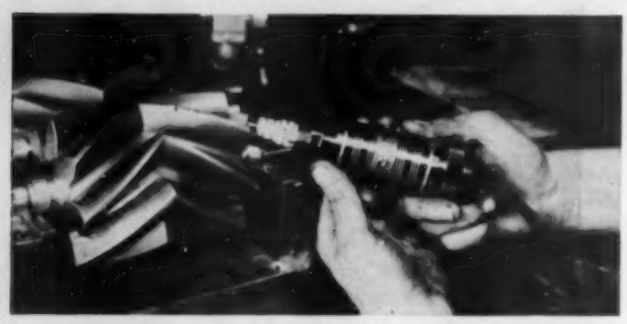
★ AS A "FIRST AID" INDUSTRIAL TOOL, FOREDOM Electric Co. recommends its Model III flexible shaft grinder kit. The Model III comes with a universal motor, has a pencil-size handpiece, and an assortment of mounted abrasive points. The grinder can be mounted on a bench, suspended from a hook or slung from the operator's shoulder by slipping a strap through the motor hanger. The kit complete weighs $4^1/_2$ lbs.

★ THE ENDLESS BELT SANDER (ABOVE) PUT OUT by Jefferson Machine Tool Co. is designed to eliminate costly hand sanding and finishing on flat, convex or concave surfaces of wood or metal. The table, which travels on ball-bearing rollers, has a 10-in. vertical adjustment to provide for work of exceptional thickness; and belt standards may be set as far apart as desired to accommodate long surfaces.

★ A COMPLETELY SELF-CONTAINED DUST COLlector is featured in Hammond Machinery Builders, Inc.'s new series of grinders, the OK-10, OK-12 and OK-14. The dust-collecting unit is mounted inside the base of the grinder, and the only outside parts are the fan motor, connecting pipes from wheel guard to dust collector and air exhaust vent guard. Because of the shape of the air ducts within the base, heavier grinding particles go to a compartment in the bottom of the filter housing, lighter ones only through the glass filters—an arrangement which, it is claimed, necessitates less frequent replacements. According to the Hammond company, these grinders require less floor space than those having separate dust collectors, and may be placed closer to walls and post supports or back to back, with adequate room for filter replacements.



★ INCREASED SPEED IN TESTING THE WEATHER-resistance of fabricates intended for outdoor use is claimed by Atlas Electric Devices Co. for their new twin-arc weatherometer (above), a machine which duplicates the action of June sunlight, rain, heavy dew and thermal shock. Increase of active light at the specimen and coordination of thermal shocks produced by cold water spray are said to be responsible for the acceleration. A robot cycle meter governs the light and thermal shock periods automatically, and the manufacturers state that no operator attention is required other than for change of samples and for reloading the arc units every 24 hours. The cycle may be modified to suit such varying materials as paint, fabric, plastics, rubber, bitumen, lacquer and varnish.



★ CLAIMED BY ITS MAKER, THE CHICAGO WHEEL & Mfg. Co., to "handle as easily as a pencil," the De Luxe Handee (above) is a high-speed electric portable tool used for grinding, drilling, polishing, cutting, carving, sawing and engraving on all kinds of materials (metals, alloys, plastics, resin, glass, wood, etc.) in factory or home workshop. The tool uses 200 different accessories, and will plug into any socket, AC or DC. The Hi-Power Grinder put out by the same company is constructed to do tough grinding jobs, operates at 17,000 r.p.m., has a lightweight alloy housing and rubber cushion insulation. Both tools may be used in the plastics industry, the company states, for grinding and polishing dies, tools, molds, jigs and fixtures, often in connection with polishing wheels; and for removing fins, drilling or cutting with steel cutters. Both are said to be handy for getting at hard-to-reach places.

Mold Automatically

19 Automatics • 24 Hours Daily Operation

The pinch of a labor shortage is already being felt . . . will become more and more acute as men are called into service.

In the production of molded plastics the Completely Automatic Molding Machines provide a partial answer to this problem . . . *they perform all functions of the molding cycle automatically.*

In one typical installation 19 of these machines are kept in continuous operation, 24 hours daily, by one man. He works one shift . . . sets up, retimes machines, changes molds, etc. In other installations whole batteries of Automatics are similarly operated by a single skilled man and unskilled helpers on second and third shifts.

- **Automatic Molding produces parts of highest quality, that meet the most exacting Army and Navy specifications.**
- **It saves molding material, 8% to 10% or more . . . particularly important at this time.**
- **It saves molding time. Cycles are reduced 50% or more in many cases.**
- **It saves tool steel, enables you to get into production quickly, with molds having only few cavities, that are quickly made at much less cost and with less steel than large conventional molds.**

Yes, Automatic Molding fits perfectly into today's all-out production effort.

F. J. STOKES MACHINE COMPANY
5934 Tabor Road Olney P.O. Philadelphia, Pa.
Representatives in New York, Chicago, Cincinnati, St. Louis, Cleveland, Detroit
Pacific Coast Representative: L. H. Butcher Company, Inc.

F.J.Stokes MOLDING EQUIPMENT

FJS Est. 1895

In the plastics picture

★ REPRESENTATIVES OF THE CANADIAN PLASTICS industry met in Toronto March 12 to consider the stringent shortage of chemicals, and problems connected with the distribution of available supplies. A committee appointed at a previous meeting reported on their survey of the country's production of classified plastics products, and a Government representative discussed the phenol supply and its effects. President Ronald Kinnear and Secretary W. T. Cruse of the S.P.I. attended a general meeting held the following day and spoke on current conditions in the U. S. plastics industry.

★ J. M. BALL, RUBBER CONSULTANT FOR THE WPB, spoke before the April meeting of the Quebec Rubber & Plastics Group on "Synthetic Rubber Compounds." Mr. Ball discussed some of the milling, plasticizing and compounding properties of several synthetics, using slides and samples for illustration.

PAUL WASSMANSDORF

★ EFFECTIVE APRIL 15, PAUL WASSMANSDORF BEcomes advertising manager of the G. E. appliance and merchandise department's plastics division at Pittsfield, Mass., where he replaces W. D. Haylon, now with the U. S. armed forces. Mr. Wassmansdorf, who has been with G. E. for 6 years, comes from the department's advertising division at Bridgeport, Conn.

On April 1, G. A. Gustafson, manager of Taunton and Meriden divisions of General Electric's plastics department, was appointed to the newly created position of supervisor of manufacturing for the department. At the same time, J. D. Milne, Fort Wayne division manager, succeeded Mr. Gustafson at Meriden, his place being taken by his assistant, C. W. Coe. New manager of the Taunton division is the plant's former superintendent, E. V. Bickford.

★ WILMINGTON CHEMICAL CORP. HAS OPENED A New York office at 10 East 40th St. The company's laboratory and plant are at Wilmington, Del.

★ THE NAME OF WALCO PLASTICS CO., 356 GLENwood Ave., East Orange, N. J., has been changed to Winbourne Plastics Molding Corp. The company's New York distributor is M. B. Price & Co., 350 Fifth Ave.

★ NEVILLE CO., NEVILLE ISLAND, PITTSBURGH, PA., has announced Notol I, a substitute for toluol, to be used as a diluent in the preparation of nitrocellulose and other lacquers. Notol I is a hydrocarbon solvent with a nitrocellulose tolerance within 80 percent of that of toluol.

★ IN DECEMBER 1941 THE STEERING COMMITTEE of the newly formed Society of Plastic Sales Engineers met and elected the following officers: Fred Conley (Chicago Molded Products Corp.), president; George Hendrie (Detroit Macoid Corp.), vice-president, G. W. Carpenter (Tennessee Eastman Corp.), secretary-treasurer. Also chosen were six directors, who have drafted by-laws for the society. Incorporated in the State of Michigan as a non-profit society, the new group has been formed for the purpose of cooperating, aiding and affecting any commercial or industrial betterment pertaining to the designing, styling, standardization and promotion of the use of plastics by the distribution of descriptive matter or personal contact or in any educational manner. Active membership is open to those interested in designing or styling of units or components requiring the use of either thermosetting or thermoplastic materials, cast resins or resinous materials; in sales or other branch of engineering in the industrial field, whether in producing plastic compounds or fabricating same; or employed in the industry in an executive capacity. Honorary memberships are extended to persons of national distinction in the plastics field, and associate memberships to personnel of the Government and the armed forces whose public service has to do with the engineering of plastics. The society lists among its aims the obtaining of maximum results from the available skilled labor, plant facilities and raw materials first for the war effort and second for civilian needs; and preparation for the eventual transition from wartime to peacetime economy.

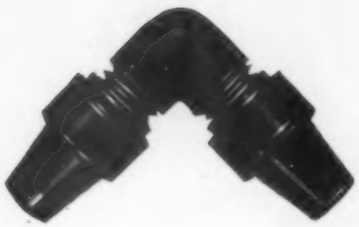
★ AT THE CASE SCHOOL OF APPLIED SCIENCE, Cleveland, Ohio, a plastics course sponsored by the Federal Security Agency of the U. S. Office of Education began in February. A series of lectures offered in connection with the course will be given by a group of men from the plastics industry: S. D. Hildebrand (Bakelite Corp.), Donald Gibb (Dow Chemical Co., Plastics Div.), H. M. Bigelow (Plaskon Co.), J. C. Pizner (Formica Insulation Co.), W. M. Lester (Pyro Plastics Co.), and J. Curtiss (General Industries Co.).

★ A WARTIME PROTECTION AGAINST FLYING GLASS is being manufactured by Roxalin Flexible Finishes, Inc., Elizabeth, N. J., under the name Roxaneal. A water-white, transparent liquid, it may be applied to ordinary window glass without obstructing vision, and also comes in blackout type. Concussion tests made of window panes coated with the plastic showed that, although the glass fractured, it remained in the frame.

★ A NEW TYPE OF LAMINATED INSULATING SHEETS, tubes and rods made with recently developed materials has been announced by Formica Insulation Co., Cincinnati, Ohio. The material shows under test 10 times the arc resistance heretofore available in such material it is reported. Under the A.S.T.M. arc resistance test, D495–41, this material will stand up from 130 to 190 sec. in the fiberglas grade. Previous materials withstood this test only for from 13 to 18 seconds. The material is provided in all the usual laminated grades—paper base, canvas base, muslin base, fiberglas base. It is also made in sheets, tubes, rods and parts that may be machined from these forms.

★ "PLASTICS FOR BETTER LIVING AND EFFECTIVE Warfare" is the title of a lecture presented before the Pittsburgh Academy of Science and Art on March 26 by Reginald L. Wakeman, Industrial Fellow at the Mellon Institute. Mr. Wakeman, in his comprehensive talk, rehearsed first the applications of plastics the U. S. citizen is likely to meet in the course of a normal day's activities; continued with a résumé of the properties of various types of plastics and their industrial applications; and devoted the latter part of his lecture to wartime uses of the materials. A showing of MODERN PLASTICS' sound and color film, "The Magic of Modern Plastics," accompanied the lecture; and experimental demonstrations supplied by Bakelite Co. and a display of consumer goods contributed by a group of firms in the industry brought out the points made by Mr. Wakeman.

5 FACTS *about* SARAN!



DOW PLASTIC BROADENS FIELD FOR MOLDED FITTINGS

The plastic fittings illustrated here are injection molded of SARAN*—the same plastic material used so successfully in extruded tubing. Together, SARAN tubing and SARAN fittings form a combination that has already measurably relieved the shortage of copper and brass.

Five important facts about SARAN make this possible. They are:

1. Chemical resistance and solvent resistance.
2. Heat resistance that permits boiling in water with little or no distortion.
3. Imperviousness to moisture.
4. Shortened molding cycle for heavy sections.
5. Dimensional stability.

These and other outstanding SARAN properties offer injection molders new and broader fields for plastic applications. For complete information write to the Plastics Sales Division today.

THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

New York · Chicago · St. Louis · San Francisco · Los Angeles · Seattle · Houston

*Trade Mark Reg. U. S. Pat. Off.

SARAN

THE CHEMICALLY RESISTANT PLASTIC

OTHER DOW PLASTICS

★ STYRON ★ ETHOCEL

★ ETHOCEL SHEETING

DOW

PRODUCTS OF CHEMICAL PROGRESS

.....WASHINGTON NEWS.....

Today, Washington is the nation's news center. To keep its readers informed on the latest national and world developments particularly affecting the plastics industry, MODERN PLASTICS has opened a Washington office under the supervision of Raymond R. Dickey. Mr. Dickey, an experienced correspondent and analyst, has a long record of interpreting news from the nation's capital and is well qualified to observe and comment on the plastics picture in that city. The first two reports below inaugurate this new MODERN PLASTICS feature.

TOOL STEEL SITUATION

While there is little likelihood that the plastics industry as such will be shut off from tool steel for molds, there is considerable possibility that high-grade alloy tool steel will soon be cut off from all manufacturers who are not doing war work. Fabricators of plastics should immediately check their plants to find out how much war business they are doing in relation to their plant capacity and output. Any fabricator who can use low-grade steel or other forms of molds instead of high-grade alloy should take immediate steps to turn to such molds.

The impending steel order will not affect tool steels. It will only forbid the use of steel in a long list of end-products—not in the machines which manufacture those end-products. However, there is considerable talk in WPB circles about putting steel under a complete allocation system similar to that under which aluminum has been since the early days of the defense effort and the priorities system. Should this be done, it is a safe bet that tool steel will be made available only for war orders or for essential industrial orders. There will not be any tool steel available for the manufacture of plastics to be used in civilian goods, if allocation is done thoroughly. Rough figures, partially arrived at through survey and partially through projecting the survey figures as being typical of the industry, indicate that about 60 percent of the output of compression molded plastics are for war orders; in injection molding, only about 10 or 15 percent of the plastics produced are for war orders. Present civilian objects made through the injection process will suffer as steel gets tighter—and steel is getting tighter daily. This simply means that on civilian goods manufacturers will have to operate to less close tolerance—or cease production entirely. With the recent crackdown on Carnegie-Illinois and Jones & Laughlin, it will also undoubtedly be more difficult to get alloy steels for non-war purposes.

Another factor, which is in the favor of the plastics industry, is that apparently a small amount of tool steel used by the plastics industry produces a large volume of goods and gives widespread employment. However, there are no statistics on this, and this lack of data will hurt the industry's case when the squeeze comes. Every manufacturer should take an inventory of the amount of tool steel used in his plant compared to the amount of material which he produces. *These figures may mean the difference between continuing in business and failure at some future reckoning date.* A negligible number of manufacturers in the plastics industry are taking advantage of the production requirements plan (PD-25A) which will soon be the master priority plan, according to a check made by MODERN PLASTICS' Washington correspondent. There is also a modified PRP (PD-25X) available for manufacturers doing less than $100,000 of business. Plastics manufacturers should study this plan *now* and make preparations to qualify under it. Gradually all other priority orders will be taken into its fold, and it will be the one guide to whether a manufacturer gets priority assistance or not. One factor which is favorable to a manufacturer using PRP is that the importance and essentiality of industries using his products is a vital factor in determining whether priority assistance will be extended or not. Under individual priority plans, the use to which the end-product is put—that is, whether it is for use or not—is the only guide to whether you rate help. PRP weighs your customers' importance, too.

WPB is planning to send each plastics manufacturer a questionnaire soon which will seek the following information: Equipment on hand; types and kind of equipment; production capacity; percentage of that capacity which is being utilized; percentage of the capacity which is being utilized on war orders; percentage of capacity being utilized by essential industries.

This questionnaire is designed to get some comprehensive picture of the place in the war effort that the plastics industry is taking. There is at present no complete picture of this in Government circles and the industry has undoubtedly suffered because of this fact. As a result, there has been little inclination to put plastics in the important place which it should occupy among war industries. There is also some likelihood that machinery and equipment not being extensively utilized on war orders may be converted to other uses where possible. R. R. D.

PLASTICIZER SITUATION FOR THERMOPLASTICS

Unless the industry can find a plentiful substitute for phthalic anhydride—and frantic efforts have thus far proved fairly fruitless—the production of two of the principal thermoplastics, cellulose acetate and cellulose acetate butyrate, may be sharply curtailed in the very near future, it is reported in Washington. Phthalic anhydride is becoming a dangerous bottleneck that threatens to curtail production of these two vital plastics as much as 75 percent.

There are two principal reasons for this growing shortage of the chief plasticizer in the field. First, phthalic anhydride is extensively used in the manufacture of flashless and smokeless powder. While the Army refuses to divulge the exact amount of its requirements, for obvious reasons of military secrecy, it does indicate that growing powder production and needs will take huge bites out of the available supplies of phthalic anhydride.

But the second reason is a lack of clear decision in the industry as to the relative importance of its products. One of the chief uses of phthalic anhydride has been in alkyd resin coatings. To be blunt, these coatings have been used in many cases where they had little functional purpose, but instead were merely for purposes of decoration. Into their production have gone comparatively large quantities of phthalic anhydride. The industry must decide whether the manufacture of cellulose acetate and cellulose acetate butyrate is more important than using the phthalic anhydride in alkyd resin coatings. The choice may be a compromise, but it should be a thought-out decision and not be on the "muddle through" policy that is currently being followed.

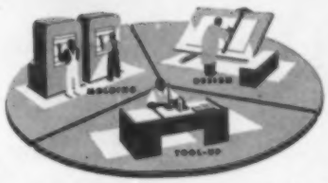
What must be realized in the industry—and it is a typical failing of many industries other than plastics—is that thermoplastic production of these two types mentioned is governed by the availability of the *most scarce item*. It is a situation where the plasticizer is the lowest common denominator which determines production capacity.

There are several things which manufacturers of thermoplastics using phthalic anhydride should do to protect themselves against future shortages. Unfortunately, these steps may result in at least a temporary curtailment of the market to a relatively small number of purchasers. But if they are not taken, the

CENSORED:

8 out of every 10 products of the Kurz-Kasch Plastics Round-Table

We can't show you many photos of moldings these days. Most of our stuff is going to war, and hence, confidential. Thus our Round-Table of specialists is doing secret service in many a Victory plant. We're loaded—but if you need help you can still Call



● At least 80% of Kurz-Kasch production goes straight into war products — the rest into goods for the nation's welfare. What's more, the same method that has made Kurz-Kasch moldings so successful in the past is still in service. In a nutshell, the Round-table is a committee of specialists on design, materials, tool-up, and production. On each new problem submitted to us, these men put their heads together, swap ideas, get all the facts necessary to do the job right, and do it promptly. On war orders involving plastics, the Round-table is *at your service.* After Victory has been won, the Round-table will again help you apply plastics to products of peace and progress.

KURZ-KASCH

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LABORATORY PRESS

This Wood 570 ton Hydraulic Press has been designed especially for modern laboratory use. There are two 8½" openings between 22" square electrically heated hot plates. Conveniently placed controls govern temperatures up to 800° F.

The two-pressure pumping unit has an adjustable pressure control; ram closing speed is 26.2" per minute, high pressure speed of 2.3" per minute and return of 30" per minute. The complete unit is fully enclosed in a steel cabinet.

R. D. Wood presses are built in many sizes, standard and special, to meet practically every requirement. Consult Wood engineers on any hydraulic press problems.

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R.D.Wood Co.

PHILADELPHIA, PA.

HYDRAULIC PRESSES AND VALVES FOR EVERY PURPOSE

manufacturer could find himself completely without materials to sell to *any* purchaser.

First, it appears to be sound business judgment at this time to ask customers for priority rated purchase orders of A-10 or better. Second, a record of those purchase orders should be kept on hand.

The reason for these precautionary steps is that the long-awaited thermoplastics priority order seems ready to break within a month or six weeks at the outside. Of course, there are 75 or 100 priority orders constantly floating through the mill and some get kicked out before they are finally promulgated. But it looks very much as if this order were in its final stages.

As the prospects now stand, thermoplastic materials will be available only for orders bearing an A-10 preference rating or better. This simply means that the manufacturer who does not have a file of purchase orders on hand bearing such ratings will have to go through all sorts of elaborate "hardship" provisions to get his material—if he gets it at all.

The order will probably also provide that purchase orders may be "basketed" for thirty days after being received so that the replacement of materials withdrawn from inventories, used to fill such orders, may be purchased in the minimum commercially procurable quantities. So it is extremely important that manufacturers keep copies of their customers' rated purchase orders on file.

R. R. D.

MATERIALS SITUATION

The constantly increasing schedules of the war production effort are still dislocating the supply of raw materials and plasticizers in the plastics industry. So far as *thermosetting* plastics are concerned, the M-25 Formaldehyde Order has definitely set forth what types of applications can or cannot be produced from the raw materials available. While this has simplified the allocation of raw materials to the plastic materials manufacturers, there are still interruptions in the supply of such raw materials which make it impossible to forecast what will be available for plastics from month to month. Unfortunately, the raw materials necessary for the production of the thermosetting types of plastics are also in demand for war uses and it is difficult for the Government to anticipate and provide for all of these requirements. In consideration of the acute metal shortages, it may not be long before all of the *phenol* materials will be used in the war program. Although new facilities for the production of phenol are under way and some will be completed during 1942, the increased demands of the war program may absorb this additional output as fast as it is available. Since last fall, phenol has been even scarcer than formaldehyde, and consequently there has been since that time some formaldehyde available for use with *urea*. The urea-formaldehyde molding compositions are available for the production of applications listed in the first and second classifications under the M-25 Formaldehyde Order. As a result, there has been some switching from phenolics to ureas for many items in both these classifications.*

For the past ninety days, the industry has been expecting a Government order controlling *thermoplastic* materials. A very small percentage of cellulosic molding powders is actually going into war production, and basic raw materials for the production of cellulosic compositions are not too scarce, but there is an exceptionally critical shortage of necessary plasticizers for these cellulosic materials. The *acrylics* are becoming more critical as aircraft production increases. Some of these materials have been available both in powder form for molding and in sheet stock for fabrication, particularly those sheets which were rejected for airplane use. With regard to *polystyrene* plastics: the styrene monomer is necessary for production of the Buna S type of synthetic rubber. Production facilities both for synthetic rubber and for styrene are being expanded, and the problem is one of timing so that production plans for both materials will keep pace. Meanwhile more and more styrene is being demanded for experimental work, and the time may soon come when all users of polystyrene will be obliged to have priorities as high or higher than those needed for synthetic rubber if they are to obtain it. *Vinyls*, particularly vinyl esters, have been widely used for coating and insulating wire for military and naval purposes. Even the expanded production facilities have all been taken up by the increased schedules for war material. Inasmuch as the reduced usage of vinyl butyral in safety glass for automobiles has released important quantities of this material, it is available for other work within its scope of applications without priority. Some vinyl acetate is also available at present without priority.

The reaction of the plastics industry generally to the war production forces which have and are still causing these irregular flows of raw materials is, unfortunately, complacent for the most part. Some molders, after more or less sporadic attempts to get war contracts either directly from Government procurement agencies through defense contract distribution, or from some local prime contractor, give up and settle back to business on hand. Others are actually getting sub-contract work by developing new plastic parts and applications which are fundamentally and economically sound. In consideration of the material shortages which have already prevailed and in view of the greater war production to come, there is only one sure way for the materials manufacturers, molders or fabricators to continue operating on the safe side: that is, *get more war work*. To do this it is necessary first to get in touch with and *cultivate* the engineers of the prime and sub-contractors and find out what they are doing and making. Next, an analysis should be made of the metal parts these contractors are using in war matériel; and those picked out which can be practicably duplicated in plastics. If the plastic replacements will be more economical or do a better job, it should not be difficult to sell them, and priorities will be available for any equipment, dies or materials needed for their production.

Thousands of machines and tremendous quantities of equipment must be built to meet the ever enlarging war matériel production plans. If very many parts for such machines and equipment can be replaced by available plastics, production facilities and raw materials will be provided for them, just as additional aluminum, magnesium, synthetic rubber, etc., are now being provided for war demands.

L. T. BARNETTE

GOVERNMENT ORDERS

★ CONSERVATION ORDER M-104 BRINGS THE USE OF tinplate and ternplate as closures for glass containers under control by the WPB. This restriction will undoubtedly have an effect on the non-decorative use of plastics in the closure field, as explained in the discussion of the materials situation on this page.

★ AFTER JUNE 30, ACCORDING TO AN AMENDMENT to Limitation Order L-81, issued April 8, manufacturers may not use any of the following materials in paints, varnishes or other surface finishes for toys and games: cellulose esters or ethers; polyhydric alcohols; acrylic acids or derivatives; vinyl chloride, acetate or copolymer; urea formaldehyde or melamine; tricresyl phosphate; dibutyl phthalate, and diethyl phthalate.

★ BY AMENDMENT NO. 4, ISSUED APRIL 8, ADDITIONAL commodities put under General Imports Order M-63 (which forbids import of certain materials without specific authorization) include chemical and munitions grades of cotton linters.

(*Please turn to next page*)

* An error in its provisional report on the relative scarcity of certain materials, issued April 17, 1942, has been admitted by the Conservation and Substitution Branch of the Bureau of Industrial Conservation, WPB. This report included urea formaldehyde plastic in Group I, which lists the materials most vitally needed for war purposes. We understand that the correction will place urea formaldehyde plastic in Group II—materials that are essential to the war industries but whose supply is not as critically limited as materials in Group I.

On best authority the urea formaldehyde plastics have been and are at present available for any applications listed in Classifications I and II of the M-25 Formaldehyde Order, and additional business has been solicited by the manufacturers. With the extremely critical condition of phenol, more formaldehyde has of course been made available for use with ureas. It is difficult to predict how long this situation will exist, due to the switch from phenolics to ureas for practicable types of work, but the present availability should certainly not be overlooked.

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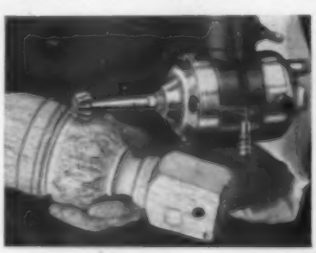
3 Carter Pacemakers in Plastics Parts Production

For CARVING and INLAYING

With plastics more important than ever due to war production, the Carter RS4 Router, with Carving Spindle and Base is helping many manufacturers to develop attractive designs and keep costs in line. It can be mounted in any position, and the power and speed (18,000 R.P.M.) is correct for small cutters. The direct drive feature eliminates vibration. Tell us what you want to cut or carve, and we'll tell you what Carter equipment you need.



FOR ROUTING TRIMMING PANELING

The men who must work "miracles" in fabricating plexiglass and other plastic parts for airplanes, ships, tanks, and other war products find the Carter Heavy Duty Overarm Router "made-to-order" for turning 'em out on time. Adaptable to every variety of routing cut, it has plenty of power for fast, clean work on any type of plastics. Available as a Router-Shaper with cast iron table as illustrated, or without base, for bench mounting. Complete information on request. Write today.

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Complete dovetail joints – blind or open – can be cut in one operation with a Carter Dovetail Templet and a Carter Router. The Templet handles two sizes of cuts – 9/16" and 9/32". The simplicity and portability of this equipment are helpful features where it must be moved from job to job in the plant. Check up on the advantages of Carter Tools and accessories for your plastics work. Write for Catalog No. 76. **R. L. Carter Div.**, The Stanley Works, 175 Elm Street, New Britain, Connecticut.

CARTER TIME SAVING TOOLS

★ ON APRIL 14, THE WPB REDUCED THE OUTPUT OF phonograph records and radio transcriptions to approximately 30 percent of the 1941 production by limiting the amount of shellac available for such uses. Order M-106 issued by the Director of Industry Operations also freezes 50 percent of all inventories of shellac of 10,000 lb. or more and 50 percent of all future imports. Use of shellac for purposes other than manufacturing of recordings is restricted to 75 percent of the corresponding period of 1941 until June 30, and to 35 percent by quarters thereafter.

★ J. S. KNOWLSON, DIRECTOR OF INDUSTRY OPERAtions, has announced that all applications for priority assistance must specify a definite date on which items requested should be delivered if the applicant's contract obligations and production schedules are to be met. Many applicants, particularly those submitting individual applications on PD-1A forms, have been writing in "immediately" or "at once" instead of giving a specific date, Mr. Knowlson said. In future, all applications not properly filled in will be returned to the sender.

★ ON APRIL 2, BY LIMITATION ORDER L-78, THE WPB ordered an immediate end to the production of fluorescent lighting fixtures except for essential uses, or on contracts accepted prior to April 2 on which work had begun. The order is expected to result in a saving of steel, copper, mercury and small amounts of aluminum, zinc, cadmium and phenolic plastics; and release facilities of the industry for essential war production.

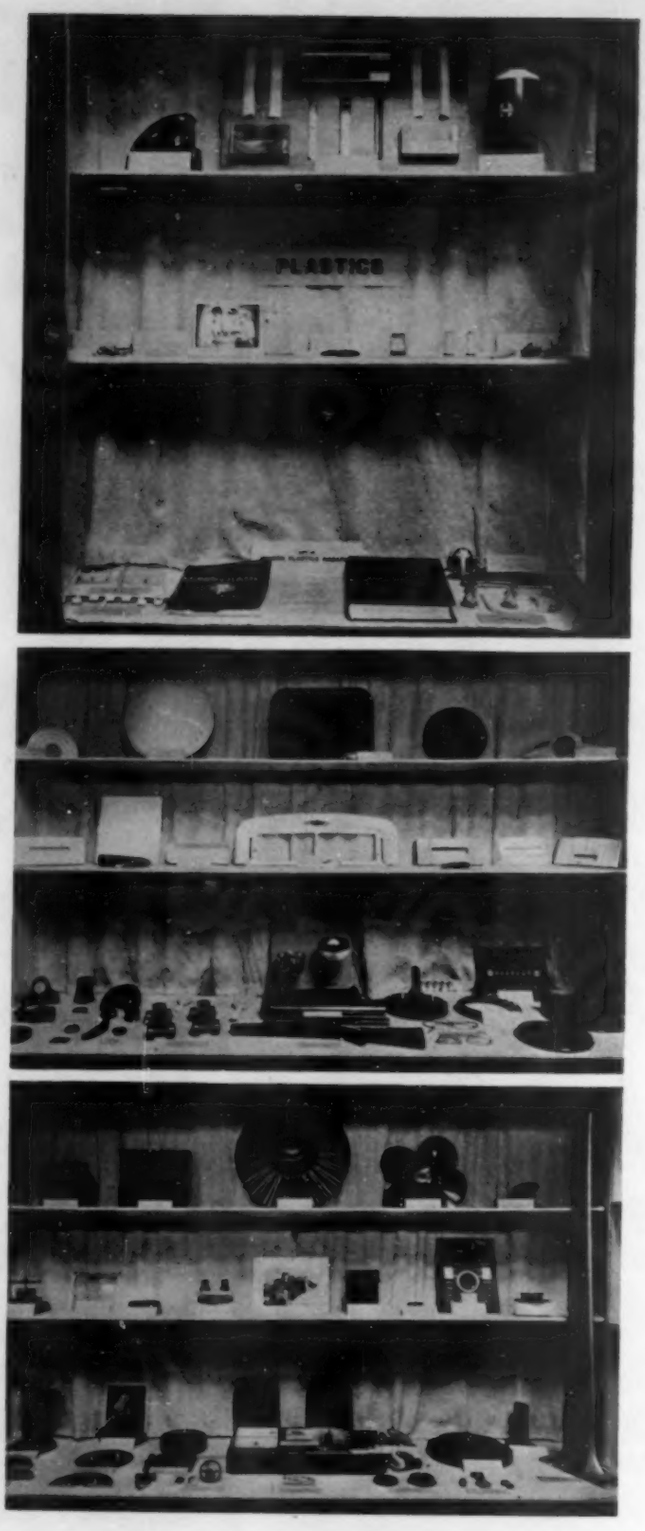
★ CONSERVATION ORDER M-56, ISSUED APRIL 16 BY J. S. Knowlson, Director of Industry Operations, restricts the use of natural resins in any calendar quarter to 50 percent of the amount used in the corresponding quarter of 1941. In certain classes of paints and varnishes, use of the resins is prohibited entirely. Reason for their scarcity is that natural resins come from trees not found in the Western Hemisphere, and limited supplies are being received. Before the war, synthetic resins, used widely in the manufacture of plastics, were used also in paints and varnishes. When war needs for phenolic and alkyd resins were anticipated, paint and varnish manufacturers were advised to rely on natural resins. Now these, too, are unavailable for civilian manufacture. These restrictions do not apply to Army, Navy or Lend-Lease contracts; to use as a non-corrosive finish in chemical plants; in research laboratories; in health supplies and in vessels other than pleasure craft.

★ ON APRIL 23, THE WPB ORDERED ALL MANUFACturers of non-commercial fishing tackle to cease using metals, plastics and cork except for hooks, which may continue to be made at the rate of 50 percent of each manufacturer's 1941 production. The order (L-92) refers only to the manufacture of the tackle; there is no restriction on sales of stocks on hand.

★ BY MIDNIGHT OF APRIL 22, THE MAJORITY OF THE nation's manufacturers of radios for civilian use had stopped production and made their facilities available for war work. The remainder of the industry will wind up its operations within a few weeks. Before the end of May, radio equipment for tanks, planes, ships and ground troops will be rolling out of these factories, R. C. Berner, Chief of the WPB Radio Section announced, adding that by the end of 1942 military radio production will be six times the volume of the industry's best previous year's output of civilian units.

PLASTICS EXHIBIT IN WASHINGTON

On permanent exhibit in the halls of the Smithsonian Institution in Washington, D. C., is a graphic story of the plastics industry's contribution to the war effort. One of a series of exhibits showing the parts various industries are playing in the national emergency, this plastics division is a representative cross section of the operation of the industry. In it appear not only direct war applications of plastics, but other developments which have resulted in the release of strategic materials for vital war applications. The exhibit is a living record of the plastics industry's achievements to date. Shown above are several of the cases which contain items contributed by MODERN PLASTICS magazine. All of these items are entries in the 1941 Modern Plastics Competition, several of them award winners in the Industrial, and Military and Defense Classifications, and additional plastic parts will be added.



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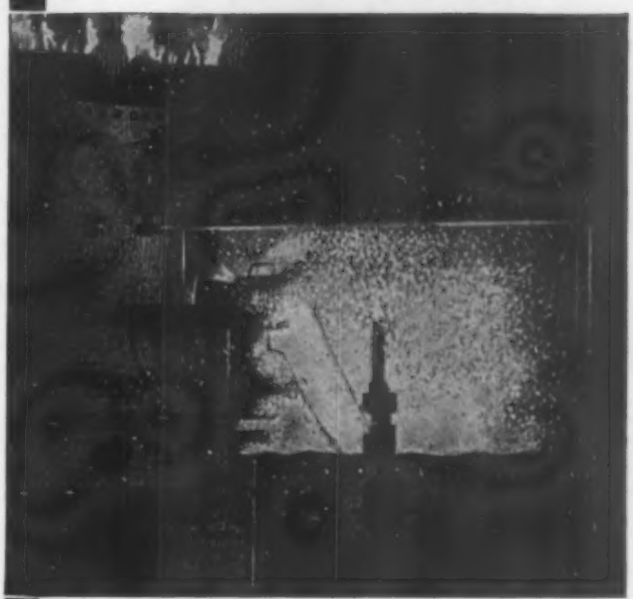

Whether your problem is a mold for some unusually intricate product . . . or a mold to produce many thousands of identical parts in your high-speed machines . . . you'll find the right answer in one of the four Disston Steels specially made for the plastics industry.

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DISSTON

MOLD STEELS . . . HOB STEELS

London Letter

AFTER two and a half years of wartime conditions over here it may be of interest to give a brief résumé of the effect of these conditions on the British plastics industry

1. *Supplies and materials*

Before the war, this country concentrated on celluloid as the main thermoplastic with an increasing use of cellulose acetate; casein was used to a large extent; phenolic and urea resins covered the thermosetting field and most of our developments were with an eye to creating new materials for civilian use. During the first few months of the war there was little change in the general economy of our plastics industry. Orders were plentiful, plants were operating at full capacity, Government work was increasing and the imports of foreign materials were gradually being reduced, to the benefit of home manufacturers. The introduction of controls, which should have come at the outbreak of war or even earlier (as you have wisely done in America) did not come until the middle of 1940; but, better late than never, it showed that the Government recognized plastics as a vital war industry—a recognition confirmed by the application, a few months later, of the Protection of Industries and Essential Works Order to plastics. Through a Plastics Control section of the Ministry of Supply (and also, indirectly, by Limitations of Supply Orders) the raw materials of plastics and the uses to which plastics can be put are now strictly controlled. Color ranges have been curtailed, raw materials have been pooled, all product ranges and sizes have been reduced. Luxury and non-essential articles made of plastics have practically disappeared from the market and the firms which made them have switched over their production to war work such as the making of aeroplane parts, gas masks, etc.

During the past year, control of raw materials has been considerably extended. Today, phenol, glycerine, cellulose acetate and plasticizers are all restricted to production "of proved importance." Extension of the war to the Pacific has created fresh difficulties, but one saving grace has been the policy of one of our biggest concerns, British Xylonite Co., in having established the manufacture of synthetic camphor some time ago. Thus we are to some extent independent of the Japanese monopoly of the natural product, lack of which would have caused our celluloid industry much trouble. Camphor substitutes (camphor equivalents in cellulose acetate plastics) are also being made, although suffering from shortages of alkyl phthalates and aryl phosphates. Unfortunately there is now a serious lack of cheap acetylene, making us very dependent on the U. S. A. for supplies of thermoplastics of the vinyl type. There are shortages of casein and cellulose, but the position is eased by strict pooling of resources among the various manufacturers.

Of the way in which peacetime plastics are being put to wartime uses, naturally few details can be given. Casein plastics are being used for knobs, spacers and other accessories on aircraft and motors, and there is a similar use for cast resin products. Thermoplastics are being used for many purposes: Cellulose acetate and acrylic acid ester plastics in transparent sheets for aircraft screens; filled acetate plastic in sheet form for non-stressed applications in aircraft construction, formerly met by light alloy metal sheet. Plastic lenses (of which there are stated to be 9000 different molds) are now being supplied to British soldiers. Plastic molded "cast window" products [See MODERN PLASTICS, Nov. 1941, p. 141] are being used in the treatment of bomb wounds, enabling doctors to peer into wounds and take cultures periodically. And so on.

2. *New products and developments*

One of the most interesting wartime developments over here has been that of melamine synthetic resins. Although melamine was first discovered in 1836, even until two or three years ago it was available only as a rare chemical, costing 10*s*. per ounce. Today it is available in ton lots at 3*s*. per lb. The ultimate raw material is calcium carbide which is first converted to calcium cyanamide (a material composed of calcium, carbon and nitrogen) by heating carbide with nitrogen gas obtained from the air. For the manufacture of melamine, the calcium cyanamide is first converted into dicyandiamide, a greyish-white powder. British Industrial Plastics, Ltd., have now patented a new process for obtaining the required materials without using expensive high-pressure plants as has been necessary in the past. When the melamine is heated with formaldehyde a synthetic resin is produced, water-white and soluble in water and alcohol, with remarkable properties in three different fields: (1) As a resin for paint and varnishes; (2) as a new molding powder; (3) as an impregnator for wood and glue for veneers for the production of strong, water-resistant laminated sheets.

Melamine resin as a molding powder is already being produced in Germany, under the trade name of Ultrapas, many beautiful moldings being made from it in the form of beakers, cups and saucers, balls, etc. It is known that the powder could be used for producing domestic utensils such as bathtubs, soap dishes, bath-spray nozzles, photographic developing tanks, and so on. As with other synthetic resins, hardened steel dies are required; but owing to the fact that the molding powder is neutral they need not be made of corrosion-resisting steel, nor need they be chromium plated. Molded objects from melamine resin are characterized by high resistance to effects of dry heat, hot water and hot beverages, and are usually free from all taste and smell. The resin does not react to fruit juices, acetic and citric acids, mustard, fats or oils.

Another significant development has been the use of synthetic resins in the production of adhesive. Aero Research, Ltd., have recently introduced a new foamed modified urea-formaldehyde glue, known as Aerolite F 67, which combines the advantages of liquid and of dry film glue with the added advantage of low cost. The new material gives plywood meeting the specification B.S.S. 5.V.3. Efficacy of the new material depends on the fact that, since only a thin film of glue is needed to make a good joint, an extremely uniform spread is obtained by using the adhesive in the form of a foam of about the same consistency as shaving soap lather. Actually the volume of the glue is doubled in a special beater machine before it goes to the spreader. Under normal factory conditions it is possible to get a spread of 1.35 lb. of glue per 100 sq. ft. The pressing temperature is 90 deg. C., so that the common type of hot water press can be used, and the lower pressing temperature avoids overheating the wood with its consequent risk of deterioration. The same company have developed another new adhesive, Ardux, which enables fully cured Bakelite materials to be sealed together. It is stated that this adhesive is so satisfactory that when fracture takes place it is actually in the plastic and not at the joint. It is a liquid mixture which is applied to the surfaces to be joined, which are then clamped together and stoved at 140 deg. C.

The furthest development yet attempted anywhere in the world in regard to the use of plastics for building is now being planned by the Building Plastics Corporation of Britain. This is the erection of an experimental house made entirely of synthetic resinoid materials. The experiment is intended to demonstrate that houses can be pre-fabricated under factory conditons and assembled on the building site with the greatest economy of time and labor. The main structure of the buildings, including stanchions, beams, purlins and bracers, will be made from plastics material (also floor elements). Window frames and astragals of plastic material have already been perfected. External and partition walls will be of synthetic material, also the roof sheets, doors and door frames. There will also be plastic stairs, including stringers, risers and treads. (*Please turn to page 98*)

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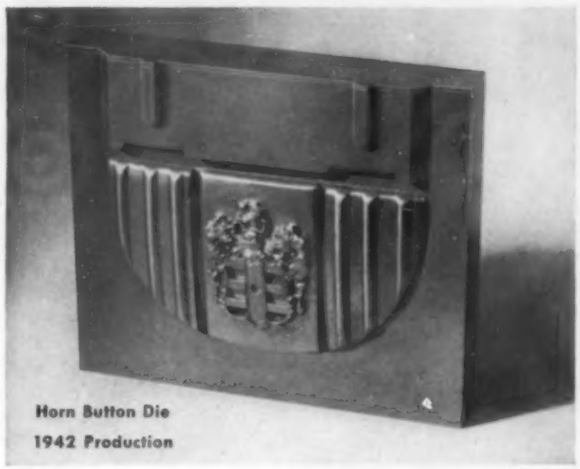

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The application of plastics materials to cables is another development which has received wartime consideration over here. It is realized that for cable dielectrics the materials used must be thermoplastic. At present there are four distinct groups of plastics materials, each group containing a number of grades, under consideration. Polyvinyl chloride compound is now being used for extreme conditions of use, both as an insulation and as a protective sheath over the vulcanized rubber insulated core. Although the insulating properties of this material are only moderate, it is unaffected by oxygen, oil, acid, etc., is resistant to flame or fire and is practically indestructible. On the other hand, it has been found that a mixture of rubber and high grade plastics materials produces good results. Polythene and styrene are being experimented with.

One final item of interest is the new denture material which has been placed on the market by Portland Plastics, Ltd., London, under the name Portex. This product belongs to the methylmethacrylate family of plastics. It is worked by the method customarily applied, a dough first being formed by working up finely comminuted solid polymer with liquid monomer. This dough is then packed into the mold and finally polymerized to a hard resistant solid by the application of heat. The new material is light in weight, has good color properties and color stability, outstanding water resistance, and is perfectly sterile. The same firm have pioneered a form of plastics teeth forming a unit block with the denture having infinitely greater strength than ordinary dentures.

3. *Organisation of the plastics industry*

Nothing has been more satisfactory than the way in which the British plastics industry—before the war a much-divided body—has unified in order to give of its best in wartime. Instead of numerous individual concerns struggling against one another, sometimes on an unsound basis and in the face of strong competition from subsidized groups abroad, we now have a fairly united front, welded together and led by the now strong British Plastics Federation. This Federation recently held its annual general meeting at which the attendance was a wartime record as, it was announced, is the membership. During the meeting, the chairman, Major Stanley M. Mohr, said: "During the past 15 months the Federation has been making itself more and more widely known and its influence is increasingly felt among Government and Service Departments. The Federation has eight separate sections in active operation. Membership increases steadily and the present total of 150 firms includes 40 applications which have been received during the past year." During 1941, Major Mohr revealed, the Federation has maintained close contact with the Ministry of Labour and National Service, and has been able to insure that reservation of plastics workers has been retained to meet the needs of the industry. The Federation was also partly responsible for persuading the Ministry of Labour to apply the Essential Works Order to plastics. As a result of the Federation's suggestions the Board of Trade exempted the plastics industry from their concentration of industry scheme until such time as the Federation shall advise them that, due to shortage of materials, labor or some other cause, there is sufficient idle capacity to warrant concentration. (*Mailed in February, 1942, by Denys Val Baker*)

Synthetic rubber in Britain

OUR enthusiastic, but technically ignorant journalists are at this moment writing some of the most appalling nonsense about the production of synthetic rubber in Great Britain. We are being told that the British chemists have mastered the secrets of the I.G. and other great German chemical concerns, and the old story of the refugee with a hidden formula is still trotted out for the benefit of a credulous public. It would all be very funny if it didn't give you a headache!

The truth of the matter is—and what a pity truth this time is not as romantic as fiction—that the official policy in Great Britain is not to set up large and expensive plants for increasing the output of synthetic rubber. Instead, attention is to be devoted to reclaiming scrap rubber and the intensive cultivation of natural rubber in our remaining Eastern plantations. In addition, it is hoped that as the American synthetic rubber industry expands, an increasing proportion of its output will become available for export to Great Britain.

This is, of course, the most logical and practical method of approach to a problem likely to become more acute with every month that passes. British chemical plants are already working to capacity, and to attempt to build up a vast new chemical industry specially developed to produce synthetic rubber would be a task beyond our strength. In addition, Great Britain has not available in sufficient quantities the basic raw materials, soft coal and lime, or alcohol from the fermentation of agricultural products. Our deposits of coal, great as they are, cannot be said to be over abundant and, indeed, this winter both industry and the home have to husband their supplies very carefully because of the shortage of labor at the pits and transport from the pit head.

Since the war, the output of neoprene types by Imperical Chemical Industries, Ltd., has increased considerably and today neoprene is in the greatest demand. This synthetic rubber is, of course, on the priority list and practically 100 percent goes to the vital war industries, particularly the aircraft industry. Imports of Perbunan are relatively small, but manufacturers are fully alive to its great value for oil and petrol-resistant jointings and packings, and also for the protective covering of special types of cables. The same remarks apply to other rubber-like polymers, particularly polyisobutylene, now utilised as an insulating medium particularly for high frequency work. It is being used in conjunction with polythene, for which it is generally used as a plasticizer.

Related to the problem of rubber supplies, it is significant that there has been a very considerable development of polyvinyl resins over recent months and increasing quantities of extrusion grades of polyvinyl chloride are becoming available for the production of cable coverings, sheathings and sleevings. In the writer's opinion, the home production of these polyvinyl products will increase considerably to cope with the greatly inflated demand for insulating materials. Every aeroplane, tank, truck and fighting vehicle requires many hundreds of yards of cable; and as the tempo of production of these implements of war increases so must the output of basic materials, and rubber and rubber-like plastics are very much munitions of war. At last we are beginning to take a leaf from the already crowded case book of our enemies. The main reason why the German chemical industry has stepped up the production of the vinyl resins to an all-time high figure is solely to relieve pressure on their true synthetic rubbers. The polyvinyl plastics are able to cover some of the ground previously thought to belong exclusively to rubber and, moreover, they give better results. The resistance of polyvinyl chloride extrusion compounds to ozone is outstanding, as are its non-aging properties and resistance to extreme cold. (*John S. Trevor*)

Sorry!

★ IN THE ARTICLE ON STYRAMIC FOR HIGH FREquency Insulation in the February issue, some of the power factors in Table III, page 70, are given as ratios and some as percentages. To convert them all to the ratio basis the decimal point of the figures for all of the materials above cellulose acetate in the table should be moved two places to the left. For example, the power factor of polystyrene at the three frequencies should be indicated as .0002, that of Styramic at 300 kilocycles as .0004, etc.

★ IN THE ARTICLE ON NAFTOLEN, ON PAGE 74 OF the April issue, the first line of the cut caption should read "oleoresinous varnishes" instead of "laminating varnishes."

from the ground UP

Plastics extruded on National Rubber extruding equipment are finding ever new uses in all fields of industry and in national defense. In the application shown, colorful, extruded cellulose acetate butyrate* is used to cover galvanized iron strips which are bent into patterns for the pouring and grinding of terazzo floors.

The plastic is found to have the accuracy, strength and wear resistance of brass, which it replaces. In addition, unlike brass, it furnishes a decorative color possibility instead of being merely utilitarian.

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(Continued from page 72)

INVESTIGATION ON THE VISCOSITY OF SHELLAC. Albert Bartovics, W. H. Gardner and H. Mark, Brooklyn Polytechnic Institute.

Specific and intrinsic viscosities of shellac in alcoholic and sodium carbonate solutions were measured at different concentrations and various temperatures. The results were discussed with the aid of the equations of Kraemer, Simha and Staudinger. This discussion led to the following results: the molecular weight of the investigated material in alcohol is around 900; the particles are only slightly solvated and their axis ratio is around 8. Comparison with the molecular models of hydrocarbons and terpenes of well-known structure points in the direction that shellac is no straight-chain molecule, neither is it a single large ring, but it seems most probable that it consists of chain and ring elements. The behavior at higher concentrations shows a distinct tendency for the formation of aggregates in solution.

ORDNANCE DEPARTMENT PLASTICS DEVELOPMENTS. Lieut. E. T. McBride, Ordnance Dept.

This résumé of the plastic substitution program includes those items which are nonconfidential. The plastic components of the Small Arms, Artillery, Ammunition, and Tank and Combat Vehicle Divisions are explained with respect to service usage, storage and the types of materials found to be satisfactory for each. It is shown that the Ordnance Department has requirements for all types of plastics—thermosetting and thermoplastic molding compounds and laminated wood, paper and cloth. Misapplications encountered during the early days of substitution are discussed. Conservation of phenolic resins will be stressed.

THE RELATIVE PERMANENCE OF INJECTION-MOLDED THERMOPLASTICS TO HEAT. E. L. Kropscott, Dow Chemical Co.

The heat permanence of a number of injection-molded thermoplastic materials is discussed. The effect which time and temperature of exposure produce upon physical properties is shown by measurements of tensile strength, impact strength, plastic flow and changes in weight and dimensions. These effects are correlated with changes in viscosity which the thermoplastic undergoes on exposure to heat. Causes for change in viscosity relative to other physical properties are pointed out.

COTTONSEED MEAL IN PHENOLIC PLASTICS. Fritz Rosenthal, University of Tennessee.

Cottonseed meal contains protein in a "denatured" form due to the cooking process preliminary to the cotton oil pressing. Even if solvent extraction be introduced in the cotton oil mill, preliminary cooking will remain an essential step of preparation. This is in contrast to the extraction of soybean oil where no cooking is required. The effect of cooked cottonseed meal on phenolic resin was studied. A composition containing 50 parts phenolic resin and 50 parts hull filler was prepared as standard compound. In one series, cottonseed meal was added in various proportions; in a second series, cottonseed meal was partly substituted for the hull filler of the standard compound. The flow of the latter series of compounds was much greater than the flow of the standard compound, indicating the influence of the cottonseed meal. The addition of meal to the standard compound was found to be in proportion to the logarithm of the data for water absorption. Photomicrographs were prepared from polished cross sections of molded bars containing various amounts of cottonseed meal, revealing the interior structure of the materials. Special attention was given a compound containing equal parts, by weight, of resin, cottonseed hulls and cottonseed meal, which had a rapid cure-time and fair flow when molded at 360 deg. F.

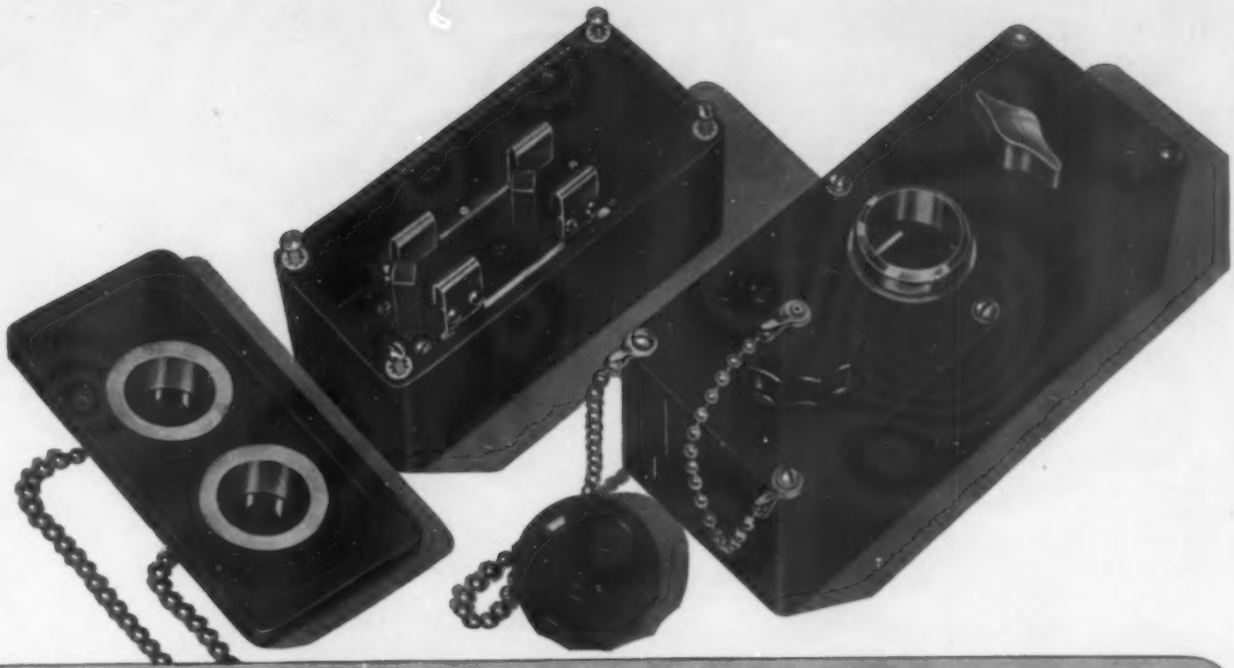
PROPOSED ELECTROPHOTOMETER COLOR INTENSITY STANDARDS FOR GRADING RESINS. Paul V. McKinney, Neville Co.

A modification of a commercial electrophotometer is proposed for the measurement of color intensity of coumarone-indene, modified coumarone-indene, cycloparaffin, terpene polymer and other synthetic resins. Comparison standards as used at present often involve a visual matching of the intensity of solutions which differ in spectral color. For example, many resin solutions have a green cast as compared to the yellow-red of the commonly used iron-cobalt standards. Other resins are yellow-red without any of the brown produced by the blue component of the color standard. The photometer reading gives the actual light transmission by the resin solution in all colors and thus produces an intensity of color scale closely approximating that visually observed by the eye. A linear color intensity scale is presented suitable for grading these synthetic resins from the lightest to darkest. For resins in present commercial production the same control samples are used as at present, substituting a reading of an instrument dial for visual comparison. The scale can be extended to lighter resins by using more concentrated solutions. By use of blue and red color filters, it is also possible to examine the spectral color type of the resin and a "spectral color" grading in addition to the "color intensity" grading will be considered in more detail at a later date. The instrument may also be adapted to determine clarity of filtered and unfiltered resins.

THE CLOUD POINT OF VARNISH RESINS IN DRYING OIL. P. O. Powers, Armstrong Cork Co.

A method has been developed for determining the solubility characteristics of varnish resins and for measuring their degree of dispersion in drying oils. The temperature at which a mixture of the resin and a mineral oil, as Nujol, clouds on cooling is a useful index of the solubility of the resin. If different mineral oils are used, it has been found that the cloud point increases with the aniline point of the mineral oil. The cloud point of resins of the same type is a useful index of their solubility in solvents and drying oils, the resins with high cloud point being less soluble.

The solubility of a resin which has been cooked into a drying oil is measured by adding one part of a paraffinic mineral oil (137 deg. maximum aniline point) to two parts of the resin-drying oil mixture and determining the temperature at which a permanent cloud develops a cooling. Varnishes containing many of the commercial phenolic, modified phenolic, maleic and hydrocarbon resins develop a cloud under the conditions of test. On heating ester type resins with drying oils at 275 deg. to 300 deg., the cloud point decreases at first but may later increase. The drop in cloud point is believed to be due to ester interchange between the resin and the drying oil. Quantitative evidence is offered for acid interchange between resins and drying oils. The rise in cloud point in the later stages of heating is due to the poorer solvent power of the bodied oil. The cloud point increases more rapidly in oils that body quickly than in those which body more slowly. Nonreactive resins increase in cloud point when they are bodied with drying oils, except in the case of resins which break down during the heating period. The cloud point method affords a rapid and simple method of comparing the solubility characteristics of a wide variety of resins, and of measuring the degree of dispersion of resins in drying oils.



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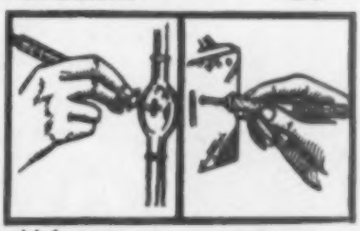

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Diffusion of light

(*Continued from page 69*) missive diffusion values, D_{ra} and D_{ta}, as determined by method A, shall be calculated, as required, by finding the ratio of S_{ra} and S_{ta}, respectively, to the corresponding $S_{max.}$, as follows:

$$D_{ra} = \frac{S_{ra}}{S_{max.\,ra}} \quad \ldots\ldots (1)$$

$$D_{ta} = \frac{S_{ta}}{S_{max.\,ta}} \quad \ldots\ldots (2)$$

NOTE 1: *Example.* Arbitrary brightness readings obtained on a smooth homogeneous plastic specimen 0.052 in. in thickness are given in Table II. The relative brightness curves are plotted in Fig. 3. Curve C_r is the reflective brightness or diffusion curve, and curve C_t is the transmissive diffusion curve.

It is seen that:

D_{ra} is evaluated by determining the ratio of the area included within UVX to that included within UVWX, in accordance with Eq. 1).

Likewise D_{ta} is evaluated by determining the ratio of areas UYX:UYZX; D_{rb}, by U′V′X:U′V′W′X; D_{tb}, by U′Y′X:-U′Y′ZX.

A summation of the areas under the curves gives the following values:

For curve C_r, by method A, area S_{ra} = 91.1 sq. cm.
For curve C_t, by method A, area S_{ta} = 26.4 sq. cm.
For curve C_r, by method B, area S_{rb} = 61.1 sq. cm.
For curve C_t, by method B, area S_{tb} = 19.8 sq. cm.

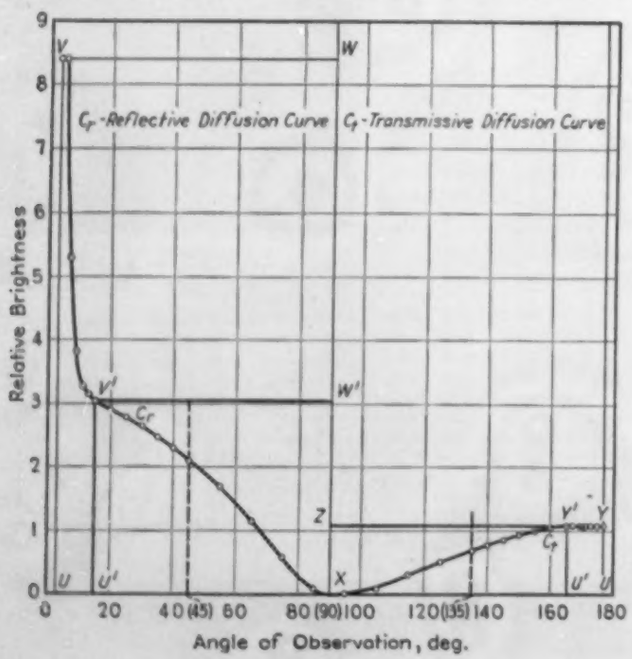
The areas under the curve for the perfect diffusor ($S_{max.}$) is as follows:

$S_{max.\,ra}$ = 365.4 sq. cm.
$S_{max.\,ta}$ = 47.9 sq. cm.
$S_{max.\,rb}$ = 114.0 sq. cm.
$S_{max.\,tb}$ = 41.3 sq. cm.

The diffusion values for the material are therefore readily determined as follows:

$D_{ra} = \frac{S_{ra}}{S_{max.\,ra}} = \frac{91.1}{365.4} = 0.25$, the reflective diffusing power by method A (including the specularly reflected component)

3—*Brightness distribution curves, typical plastic specimen*



$D_{ta} = \frac{S_{ta}}{S_{max.\,ta}} = \frac{26.4}{47.9} = 0.55$, the transmissive diffusing power by method A.

$D_{rb} = \frac{S_{rb}}{S_{max.\,rb}} = \frac{62.1}{114.0} = 0.55$, the reflective diffusing power by method B (excluding the specularly reflected component).

$D_{tb} = \frac{S_{tb}}{S_{max.\,tb}} = \frac{19.8}{41.3} = 0.48$, the transmissive diffusing power by method B.

TABLE II.—TEST RESULTS FOR TYPICAL PLASTIC SPECIMEN 0.052 IN. IN THICKNESS

Angle of observation, deg.	*Galvanometer deflection*	*Angle of observation, deg.*	*Galvanometer deflection*
3	8.40[a]	95	0.01
5	8.40[a]	105	0.10
7	5.30[a]	115	0.33
9	3.82[a]	125	0.52
11	3.28[a]	135	0.70
13	3.15[a]	140	0.78
15	3.05	145	0.87
20	2.90	150	0.94
25	2.80	155	1.01
30	2.65	160	1.06
35	2.46	165	1.09
40	2.31	167	1.10[a]
45	2.10	169	1.10[a]
55	1.71	171	1.10[a]
65	1.16	173	1.10[a]
75	0.61	175	1.10[a]
85	0.11	177	1.10[a]

[a] This measurement is used in method A, but not in method B.

NOTE 2. It can be seen from the example in Note 1 that the choice of method A or method B depends upon whether or not there is a well-defined specularly reflected or transmitted component and also, whether or not it is desired to show the overall diffusing power including this component or to indicate only the light scattering ability of the specimen, independent of its surface characteristics. Obviously, for a material having a matte surface, there is little value in using method A when the simpler method B will give almost the same result. Likewise method B is to be preferred in transmissive diffusion measurements on a highly diffusive material.

(*e*) If it is desired to compare graphically the diffusing properties of several specimens by means of their light distribution curves, the maximum brightness reading for each specimen shall be converted to 100 and the readings at other angles shall be modified in like ratio before plotting the points on Cartesian coordinates. The area under each curve is then proportional to the diffusing power of the specimen represented (Fig. 4).

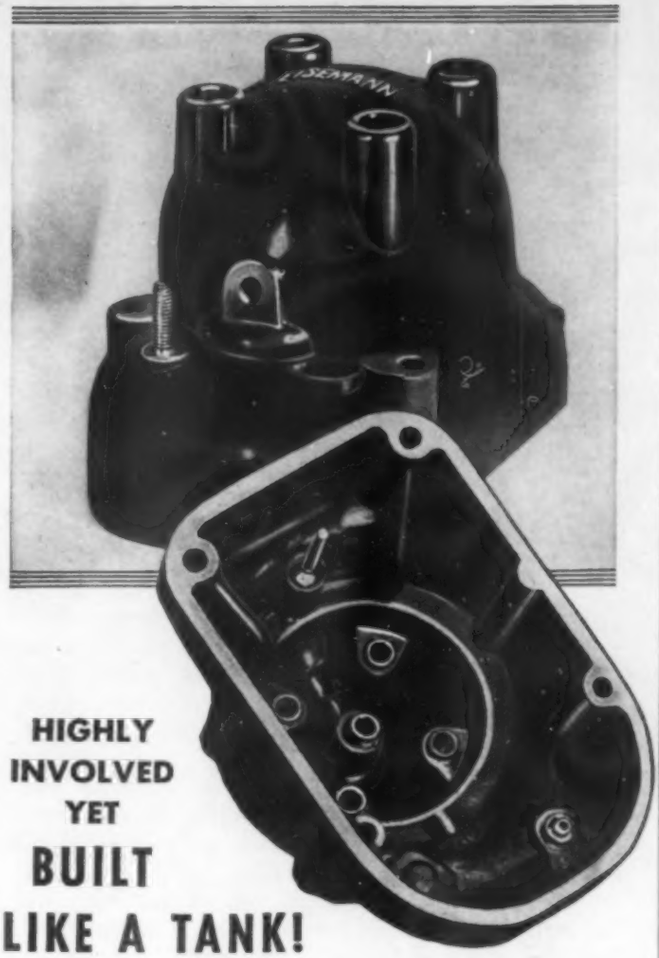
Report

6. The report shall include the following:

(1) The diffusion values for transmission and reflection, as required, expressed as a decimal,

(2) The values of D_r and D_t expressed to the nearest 0.05 above 0.50, to the nearest 0.02 from 0.25 to 0.50, and to the nearest 0.01 below 0.25,

(3) The thickness of the specimen to the nearest 0.001 in., except as noted in Section 3 (*c*) for special and configurated materials, when the necessary dimensions and configurations shall be fully described, (*Please turn to next page*)



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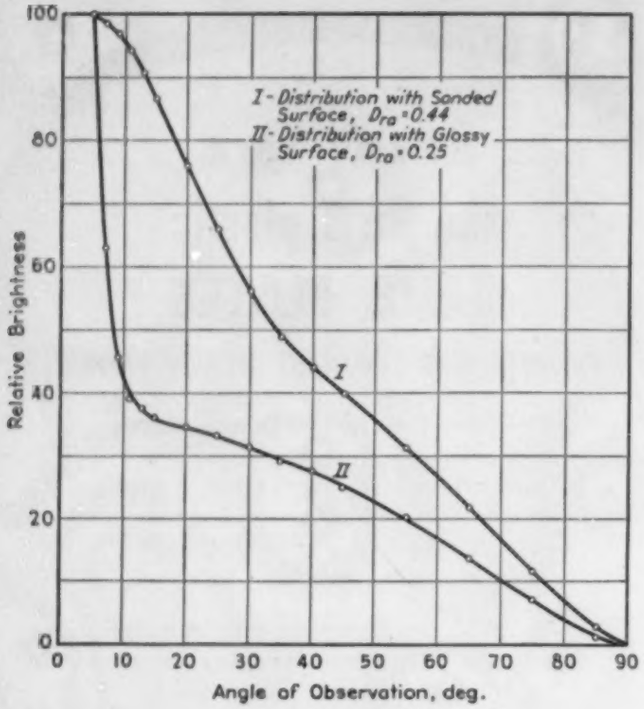

4—Graphical comparison of reflective distribution curves for plastic specimens

(4) The physical condition of one or both surfaces, depending on whether a determination is made only for D_r, or whether both D_r and D_t are measured, as described by one of the following terms: polished, smooth, matte, grained, pebbled or configurated. If the material is grained, pebbled or configurated, more than one set of results shall be reported, if necessary, orienting the specimen surface differently for each test as specified in Section 4 (*d*).

The Army helmet liner

(Continued from page 38)

E-1b. Shall be comfortable to wear with or without the helmet, steel, M-1.

E-2. The liner body shall be fitted with a suspension having a suspended headband, neckband, and adjustable chin strap to conform with applicable drawings.

E-3. The liner body shall be a coated one-piece laminated phenolic resin impregnated fabric, free from dents, seams, cracks or other imperfections affecting the appearance or quality. The coated surface shall be free from pimples, blisters, blushing, cracking, checking, pin holes, or other imperfections of surface.

E-4. *Color*—The color of the coating for outer surface of liner body shall be olive drab conforming to color standards of Q.M.C. Tentative Specification ES-680. A somewhat similar olive drab color shall be ingrained in the liner body material.

E-5. *Finish*—The finish for the outer surface shall be smooth and dull, non-light-reflecting, suitably resistant to abrasion and scuffing. The coating shall adhere firmly to the liner body throughout all tests specified herein. If baking is necessary, the coating shall not be baked at a higher temperature than 225 deg. F. for 15 minutes, or 200 deg. F. for 30 minutes. The surface of the interior of the liner body must be smooth and free from irregularities which would affect the appearance or utility.

E-6. *Odor*—There shall be no objectionable odor emanating from the liner body throughout the range of −40 deg. to 160 deg. F.

E-8. *Weight*—The weight of the body, without suspension, rivets, chin strap, but with outside coating shall not exceed $7^{3}/_{4}$ ounces. The weight of the body with suspension, rivets, chin strap, etc., shall not exceed $11^{1}/_{4}$ ounces.

E-9. *Moisture Sorption:*

E-9a. *Uncoated*—The uncoated liner body shall not increase in weight more than 5 percent when immersed in water for 24 hours at 77 deg. ± 4 deg. F. When removed from the water and dried in a forced draft oven at 140 deg. ± 5 deg. F. for 24 hours, the decrease in weight from wet weight shall not exceed 6 percent. The uncoated body shall be tested a minimum of 8 hours after removal from mold and shall be exactly as it comes from the mold, except for removal of flash and protective coating of the exposed edge.

E-9b. *Coated*—The coated liner body shall not increase in weight more than 5 percent when immersed in water for 24 hours at 77 deg. F. ± 4 deg. F. There shall be no peeling, cracking, blushing, checking, blistering or other failure of surface coating when examined 4 hours after removal from water. The liner body shall be dried in a forced draft oven at 140 deg. ± 4 deg. F. for 24 hours and the decrease in weight from wet weight shall not exceed 6 percent.

E-10. *Dimensional Stability*—The mean diameter and mean thickness of the uncoated body shall not increase more than 0.5 per cent and .002 inch, respectively, when immersed in water for 24 hours at 77 deg. ± 4 deg. F. When removed from the water and dried in a forced draft oven at 140 deg. ± 5 deg. F. for 24 hours, the decrease in mean diameter and mean thickness of the body shall not exceed 0.5 percent and .002 inch, respectively.

E-11. *Ball Test:*

E-11a. *Uncoated*—The uncoated liner body without suspension shall withstand the impact force of an 8-pound iron ball of approximately 3.9 inch diameter, dropped on its top at a distance of 15 inches, or 10 foot pound impact. Deflection on impact shall not exceed more than 1.25 inches. The permanent deformation shall not exceed more than 0.1 inch. There shall be no fabric break, splintering or delamination on impact. The 8-pound iron ball shall be dropped again on its top at a distance of $22^{1}/_{2}$ inches or 15 foot pounds impact. There shall be no fabric break, splintering or delamination of the liner body, but the surface may be dented.

E-11b. *Coated*—When test described in E-11a is repeated on the coated liner body there shall be no flaking, cracking, peeling, checking, blistering, loss of adhesion or other failure of coating.

E-12. *Resistance to Delousing Treatment*—The uncoated liner body shall withstand saturated steam at 17 pounds per square inch (253 deg. F.) for 30 minutes without substantial change in dimensions, physical characteristics and appearance which would affect the serviceability of the liner body.

E-13. *Flammability*—The phenolic resin impregnated fabric shall consist of either non-flammable or slow-burning material. The rate of burning shall not exceed 4 inches per minute.

E-15. *Flexibility*—There shall be no breaking, cracking, delamination of the liner body when subjected to the flexing test described under section F-3f. (*Please turn to next page*)

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E-16. *Weather Resistance*—A cut section of the coated liner body shall be subjected to a recognized standard weathering test for a period of time comparable to one year's Florida sun exposure. At the end of that time there shall be no blushing, cracking, checking, blistering, peeling, loss of adhesion or other failure of surface disregarding edge effect. The fading of color shall be slight.

E-17. *Ballistics Impact Resistance*—The liner body shall be placed inside a standard helmet, steel, M-1, body, with full suspension installed in liner and shall be mounted on a wooden head. A .45 caliber pistol with regular Army ball type ammunition shall be fired at the steel helmet, one normal to the helmet at the right temporal, one normal to the helmet at the left temporal, and one normal to the helmet occipital region thereof. The velocity of impact shall be approximately 790 feet per second. There shall be considerable indentation of the steel, but no penetration. If there is penetration, test shall be reconducted with another steel helmet. The liner body shall show only fracture within areas of impact with no fragmentation in any instance. If fabric is torn, there shall be no loose particles. There shall be no flaking off of interior finish in this test.

F. Methods of Sampling, Inspection and Tests

F-3. *Testing:*

F-3a. *Moisture Sorption and Dimensional Stability*—The changes in weight, mean diameter, and mean thickness of the liner body as a result of immersing in water for 24 hours at 77 deg. ± 4 deg. F. are found by taking the difference in measurements made before and after the water immersion period. The mean diameter is obtained by averaging two measurements which are made at right angles to each other and approximately one inch from the edge. The mean thickness is obtained by averaging four measurements which are made at regularly spaced positions along the base of the liner body and approximately $^3/_4$ of an inch from the edge. The liner body, after the water immersion test, is placed in an oven at 140 deg. ± 5 deg. F. for 24 hours and the changes in weight, mean diameter, and mean thickness determined. The percentage changes from the initial state to the wet state and from the wet state to the oven-dried state are calculated using the initial measurements as the base. The liner body shall be conditioned for 48 hours at 77 deg. ± 4 deg. F. and 50 ± 2 percent relative humidity before this test is made.

F-3b. *Ball Impact Strength*—The ball impact test is made by dropping an 8-pound iron ball, diameter approximately 3.9 inches, on the top of the liner body at 77 deg. ± 4 deg. F. The liner body shall be placed on a contoured block so that it rests evenly along the entire edge. The ball is released by burning the cord which is used to suspend the ball above the liner body or by any other suitable method. The distance of drop is measured from the bottom of the ball to the top of the liner. The deflection on impact is measured by putting inside the liner body an apparatus which consists of a greased metal rod in a close-fitting metal tube mounted in a holder with top of rod set $1^1/_4$ inches below crown. If the impact forces the rod further down into the tube, the liner body shall be reported as a failure. This test shall be made on the liner body which has been subjected to the water immersion and drying cycle described in F-3a.

F-3c. *Suspension Impact Test*—The liner, helmet, M-1, within a helmet, steel, M-1 body, should be mounted on a tapered Tyrolean Style head block, $7^1/_4$ head size, in a position similar to that when on a man's head. A clearance of $1^1/_4$ inches between liner body and block shall be determined by putting a 25-pound weight on the liner and measurements made by means of a rod inserted in a hole drilled in the center core of the wooden block. The liner shall withstand impact of an 8-pound spherical weight, approximately 3.8 inches in diameter, dropped vertically to the center of the crown (highest point of liner) from a height of 5 feet, from the bottom of the ball to the top of the liner, without breakage or failure of suspension tapes, rivets, stays or suspension cord.

F-3d. *Thickness of Crown*—The mean thickness of that portion of the liner body enclosed by a circle of 2-inch radius, and whose center is at the top of the crown, shall be measured.

F-3e. *Flammability*—The specimens for this test shall be cut from the liner body with the long dimension parallel to the brim, between 1 and 2 inches from the brim, and from that part of the liner body which will permit a sample with the least curvature. The specimens shall be 6 inches by 0.5 inch by the thickness of the liner body material and shall be conditioned at 77 deg. ± 4 deg. F. and 50 ± 2 percent relative humidity for 24 hours before testing. The test shall be conducted in a location protected from air currents. The test specimen shall be clamped in a support at one end with the longitudinal axis of the strip horizontal and the transverse axis inclined at 45 deg. to the horizontal. Lines are marked on the sample at distances of 1 and 4 inches from the free end. An alcohol lamp or gas burner with a flame 0.5 to 0.75 inch in height is placed under the free end of the strip adjusted so that the flame tip is just in contact with the sample. At the end of 50 seconds, the flame is removed and the sample allowed to burn. A stop watch is started when the flame reaches the 1-inch mark and the time observed when the flame reaches the 4-inch mark. In case the fabric does not continue burning to reach the 1-inch mark after a second ignition, the sample shall be reported as self-extinguishing.

F-3f. *Specific Gravity*—The specific gravity shall be measured by the water displacement method.

F-3g. *Flexing Test*—A $^3/_8$-inch by 6-inch iron rod is mounted in a vertical position in a sleeve holder clamped to a ring stand which is fastened firmly to a work bench. One side of the liner body is clamped between the base of the stand and the lower end of the rod. The rod should be within the liner body on the short diameter, clamped approximately 1 inch from the brim or edge. Another rod is mounted so that the end is $^1/_2$ inch above the top side of the liner body. Then by hand the upper side of the liner body is flexed between the ends of the 2 rods so as to obtain 6 complete cycles in 5 seconds. No cracks or other fracture shall be apparent in the liner body when it is subjected to the 6 flexing cycles.

F-4. *Shape*—Ten liners selected at random from each lot shall be tried for a proper fit in sample "A," standard helmet, steel, M-1 body and shall be inserted with reasonable hand force into sample "B," steel helmet body supplied by the contracting officer. At the discretion of the inspector, a liner may be selected from any lot or lots, submerged in water 75–80 deg. F. for 48 hours, air dried, and tested for shape as above.

F-5. *Rejection*—Failure of any sample to comply with the requirements set forth in any of the above tests shall be cause for rejection of the lot, except that a retest may be allowed as described below.

F-6. *Retest*—Failure in any test or malfunctioning of any part shall be cause for retest of twice the number of the original test specimens from the lot. Failure of any specimen in the retest shall be cause for rejection of the lot.

(*Please turn to next page*)

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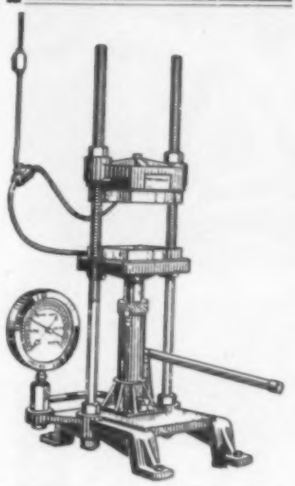

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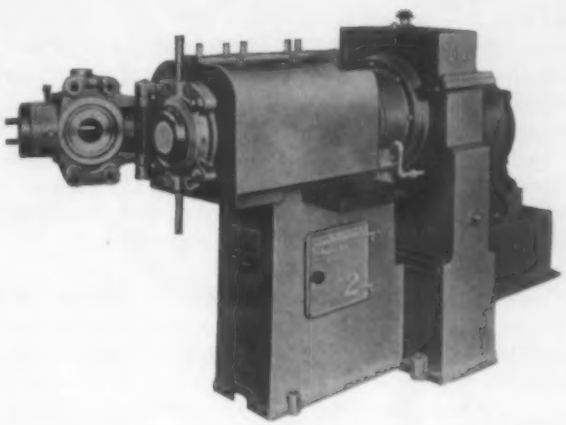

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F-7. Components or finished units which have been rejected individually, may be conditioned and resubmitted for inspection and test. Rejected lots may be conditioned and resubmitted only with written approval of contracting officer.

Zinc alloys for molds

(Continued from page 70) plastics, acrylics and polystyrene. Coarse granules and fine powders were molded with the mold, giving under all conditions a performance comparable to that of steel.

In the construction and mounting of the molds it is preferred that they be used as inserts in steel or cast iron frames or mounted on steel plates. In Fig. 3 is shown a low-cost, simple zinc alloy mold which was used for reproducing several hundred molded phenolic and molded urea parts. The only steel parts used in this mold were the guide pins, the guide-pin bushings, mounting plates and knockout pins. The mold was given a high polish and electroplated, inasmuch as zinc alloy polished surfaces will lose their luster when maintained at high molding temperatures for several days.

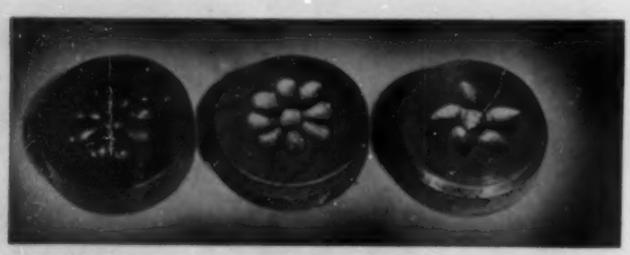
One of the outstanding qualities of zinc alloy molds is the ease with which they are polished to a mirror-like finish. The surface is rather dull where it makes contact with the sand pattern but some steel wool and mild polishing abrasive will develop the luster required. Of course a dull surface may be satisfactory for contrasting purposes, though generally for good release from mold surfaces a polished face is best. There is very little tendency for pieces to stick on zinc alloy molding surfaces. In fact, their release appears better than that obtained when the molding surface is of steel.

The use of zinc alloy molds in the plastics industry has definite possibilities in the following fields:

1. Low cost molds for limited production.
2. For decorative articles where accurate machining is not necessary.
3. Experimental molds or parts of molds.

The metal itself will pour readily and make a good reproduction of all details appearing in the sand pattern. Figure 4 illustrates a small cover for a molded package. The floral pattern can either be machined on the surface of the zinc alloy with a portable electrical engraving tool or reproduced on the plaster model which reproduced the sand pattern.

In Fig. 4 the molded article is distinguished by a mottled color, while two zinc alloy mold inserts are shown adjacent to it. Zinc alloy may be conveniently introduced as mold inserts, and removed or replaced as frequently as may be desired in either compression or injection molds. They will not be so good as hardened steel nor so long wearing, but they will serve for limited production and can be reproduced by relatively unskilled help. They undoubtedly are of potential value to the plastics industry.



4—Small molded cover (left) showing a floral pattern, and two zinc alloy mold inserts which may be introduced either into compression or into injection molds

5

6

PHOTOS, COURTESY RESINOUS PRODUCTS & CHEMICALS CO.

5—Layers of coated veneer for the deck of a toboggan ready to slide into the autoclave at rear. Operator at right is attaching plywood runners to under side of toboggan. At left, a vacuum tube is being attached to the rubber bag, here partially pulled over the assembly.
6—Inspecting toboggans as they come from the autoclave

"Working" skis

(Continued from page 51) Bag and contents are then placed in an autoclave, or tank, which is closed with a tight sealing door and filled with compressed air and steam. The type of adhesive used and the distance of the farthest adhesive line to be cured from the source of heat govern the sequence or combination in which the pressure and heat are applied. The length of the heating cycle is from 15 to 30 minutes, varying in accordance with the type of resin used.

Skis are made either in a gang, to be sawed apart after the plywood is bonded, or as individual units. Most of the veneers are laid lengthwise, to obtain the desired stiffness in that direction, though cross layers are occasionally used. The company describes its product as laminated wood rather than as plywood, although the skis and toboggans are made by the plywood process.

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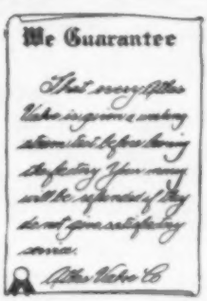

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(Continued from page 67) with boiling water or atmospheric steam. Without internal support, this tubing can be permanently bent without kinking to a radius as small as 3 to 6 times the diameter of the tubing. Bends can be made to an inside radius as small as one-half the diameter of the tubing by the use of the same technique, but with the addition of an internal fluid pressure. By this method, it is possible to fabricate many complex shapes, such as elbows, traps, nozzles, etc., where a permanent set is necessary.

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High density plywood

(Continued from page 63) sity plywood to spruce, suggests the advantage of using a variable density propeller blank, in which the high density at the hub end will provide adequate strength for attachment to the engine, and low density at the outer tip will reduce centrifugal forces to a minimum[9] (Fig. 2). Another variable density propeller construction, without the scarfed joint, is shown in Fig. 1, where the length of the layers may be varied to obtain any density gradient that may be required.[13] The entire assembly is pressed to a uniform thickness, using thickness gages in the hot press. Indications favor laminated wood, i.e., parallel grain constructions, in this propeller work.

Other variable density applications to civilian uses are readily suggested, where certain portions of wood products require maximum resistance to impact, such as picker sticks that drive the shuttles on looms.

Ultimate density obtainable

Wood fiber, or cellulose, has an ultimate specific gravity of about 1.55, while that of the phenolic resins in use is from 1.30 to 1.40. The maximum density that is reasonably attainable is of the order of 1.30 to 1.35. Lower densities can be obtained by less impregnation and lower specific pressures, and are not difficult to control and reproduce. Normal spruce is .35 to .40, poplar .40 to .45, birch .60 to .70. In densification operations it is difficult to keep below .75, and a general minimum is around 1.00. It is to be noted that the normal specific gravity of lignum vitae and ebony is around 1.25,[13] so that their desirable qualities of hardness can be readily equaled in high density plywood. This facility is of definite practical importance, since these very dense woods are difficult to obtain, and normally occur only in small dimensions.

Industrial applications

The use of high density plywood, with graduated density, has been suggested for two types of airplane propeller constructions.[9, 13] Still another development along a similar line is that of trimming each sheet of impregnated veneer to a trifle over its ultimate shape and size, and then curing the

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WANTED: LUCITE FABRICATOR, man with experience and full knowledge of fabricating operations and assembly. To take complete charge of established plant, fabricating Department store items. Write giving full particulars and details of your experience, and state salary. Reply Box 547, Modern Plastics.

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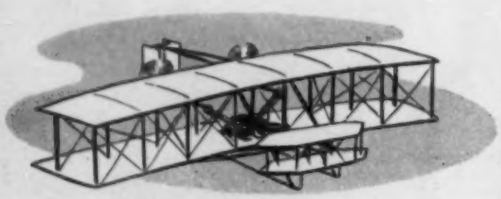

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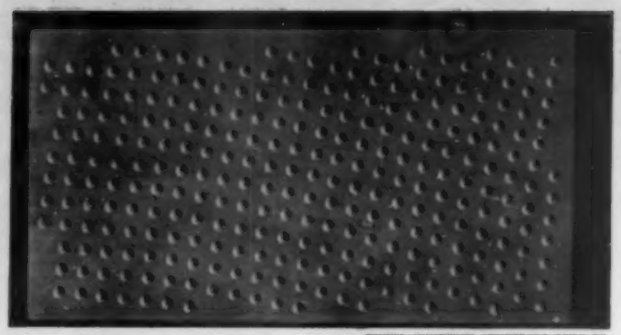

PHOTO, COURTESY ARMSTRONG CORK CO.

3—High density plywood with embossments serves as a reinforcing plate, with embossments drawn by bolts into the spruce spar of an airplane to anchor wings to the fuselage and landing gear in a strong mechanical grip

assembly under heat and pressure in a pair of metal molds. These molds press the propeller blade to its exact shape and twist, leaving only a very slight amount of material to be turned off after cure.[14] Extra layers of veneer can be inserted in the hub section for higher density requirements.

Another aircraft use is reinforcing plates, where spruce spars are connected to fuselage and landing gear, a point of concentrated loads. Such plates may have embossments, about $^1/_8$ in. above the surface, to be pressed into the spruce of the spar by bolts, which will distribute and supplement the shear resistance of the spruce under bolt loadings.

Other aircraft applications are gusset plates on ribs; formed clips and attachment lugs for anchoring plywood to framework; floors, walls and wing coverings of high density exterior and low density interior; instrument panels; and adjustable seats.

Defense uses other than aircraft are stems, ribs and reinforcing plates in boats, bases for landing flares, forming dies for thin metals, gun stocks and the like.

Since aluminum and its alloys have a specific gravity of around 2.8, high density plywood will be only half as heavy. This strength/weight ratio opens up wide fields of adaptations that will conserve the more essential metals.

Industrial uses in civilian classifications are many, but they are considerably restricted for the time being by the rigid allocations that exist in the supply of phenol and formaldehyde. Among them may be mentioned textile equipment, taking the place of very hard woods or the lighter metals; silent gears instead of rawhide or vulcanized fiber; hollow gun stocks; roller skate wheels and casters; handles; insulating clips, braces and parts for electrical equipment; models; dummies; forming dies; automotive parts; brush backs; radio, phonograph and piano parts; and stocking drying forms.

Conclusions

Engineers who have studied the strength and quality characteristics of these high density plywood constructions, made by any of the techniques outlined, consider them challenging products for many types of utilization. Even at maximum densities attainable, bulk of high density plywood may be doubled to equal aluminum weight, while its strength/weight properties give it definite and distinct advantages. The facility with which strength factors can be predetermined and adjusted to meet special problems, affords a remarkable range of promising possibilities.

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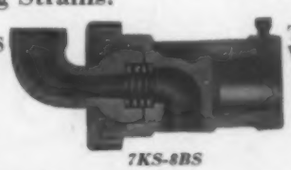
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ence more extensive, the economic status and most logical uses of high density plywood cannot be fully determined.

The combination of wood veneers, easily obtainable and readily workable, with modern plastics affords distinct encouragement to those who are still forging ahead toward the broadening industrial opportunities of the future.

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Coating extruded fibers

(Continued from page 55) to .001 inch. Thin cotton threads, heavy cords, fiberglas fibers, tapes or various gages of wire can be used as the support. Thus by the use of over 17 different formulae, employing a variety of thermoplastics (cellulose acetate, ethyl cellulose, cellulose acetate butyrate, etc.) and different cores, the finished product may be a flexible yarn or a heavy tape.

The process can be applied to yarns in continuous lengths. Material formulae had to be re-adapted from French formulations to incorporate available American plastics. Changes in machinery construction and in technique were also necessary because of American applications of the yarn to power-looming. In France, the material's uses had been confined mainly to manual manipulations. One development of the process has achieved color on yarns which could not be dyed properly by former methods.

The manufacturer claims unusual tensile strength and dimensional stability for his yarn because of the core or support, states that the material is proof against cracking or breaking and is accurate through continuous lengths. Selection of the type and weight of the material to be used as the center allows the user to determine the actual strength of the finished yarn. In addition, the material is said to be grease- and water-proof, and resistant to mild acids. At present, these plastic-coated fibers are available in diameters of .008 in. to .90 in., and they can be spooled, coned or hanked. (*Please turn to next page*)

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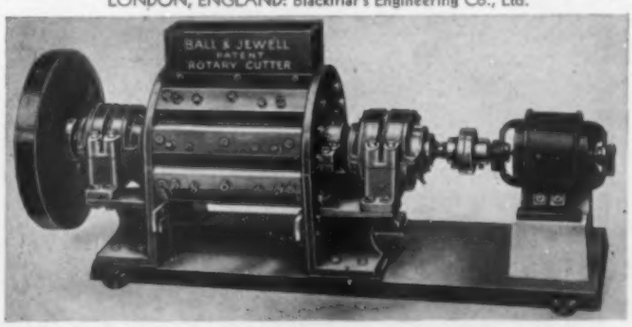

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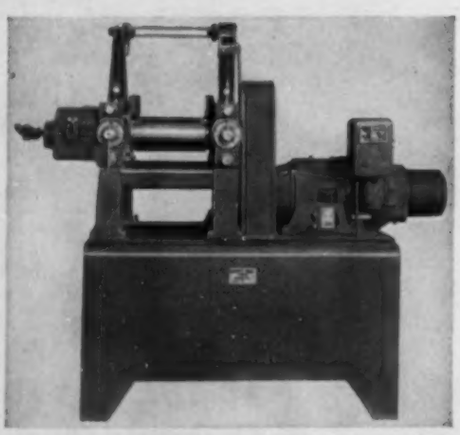

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Applications for this yarn are legion, though the largest outlet at the present time is in the fashion, handicraft and home furnishing fields. Smart, highly serviceable handbags woven or crocheted from solid, multicolored and plastic-coated yarn are a leading note in the spring and summer fashion markets (Fig. 1). Of particular interest is the type shown in the foreground made from yarn woven on a wide loom. Belts, suspenders, jewelry and millinery are other accessory notes. The yarn has also been made into manikin wigs, dog leashes, table mats, fishing line, screens, pile fabric upholstery and furniture trim. It is used in Chantilly lace for a delicate highlight and has been woven into sturdy, perspiration-proof toggle straps and robe racks used in passenger automobiles. Florists have used plastic-coated wire for tying corsages and making attractive, coiled ornaments.

The plastic-coated cord has been put to work in novel ways by industrial concerns. For example, Westinghouse Electric & Mfg. Co. used a dull silver-coated cord in lieu of wire or ordinary cord to attach informative labels to various electrical appliances and refrigerators. The plastic-covered cord looks like metal but is as pliable as cord, more durable and yet will not, like uncovered wire, scratch smooth enameled or painted surfaces. In addition, its use releases metal for other needs.

Credits—Materials: Plexon, Colacord, Colatape by Freydberg Bros.-Strauss. Bags: Top row, by Josef; bottom row by Garay. Distributor of yarn: Majestic Rayon Corp.

"This Plastic Age"—new film

(Continued from page 59) pre-fabricated houses and a multitude of things which not only contribute to a successful war effort, but also promise that, when this job has been successfully accomplished, the plastics industry is ready and waiting to assume the responsibility of helping to rebuild a civilization that boasts of grace, comfort, beauty and utility.

The "here and now" rôle of plastics in the war is demonstrated by dramatic sequences showing the use of plastics in the planes, the tanks, the guns and the ships whose speed, efficiency, safety and utility have all been enhanced through the use of plastic materials. The film shows how the very plastic materials which began by being substitutes for strategic materials required for the war effort, have themselves become the strategic materials indispensable to the construction of an American arsenal today.

And tomorrow, after the war is won, the film visions a future enriched with plastics—plastics for cars, for civilian planes, for furniture, refrigerators, objects of art, for clothes, for better homes and for better living.

The film has been treated as a documentary presentation which derives considerable dramatic force from the presence of a star-studded cast, including such luminaries of American art and industry as Glenn L. Martin, President of the Glenn L. Martin Aircraft Co.; Harvey Wiley Corbett, well-known American architect, former judge in Modern Plastics Competitions and one of the earliest pioneers in pre-fabricated housing; Robert A. Boyer, Head of Research for the Ford Motor Co.; Norman Bel Geddes, industrial designer of World's Fair fame; and Hattie Carnegie, famous couturiére. The film commentary is delivered by Milton Cross.

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